PLASTICS

APRIL 1961

THE MAGAZINE OF APPLIED ENGINEERING

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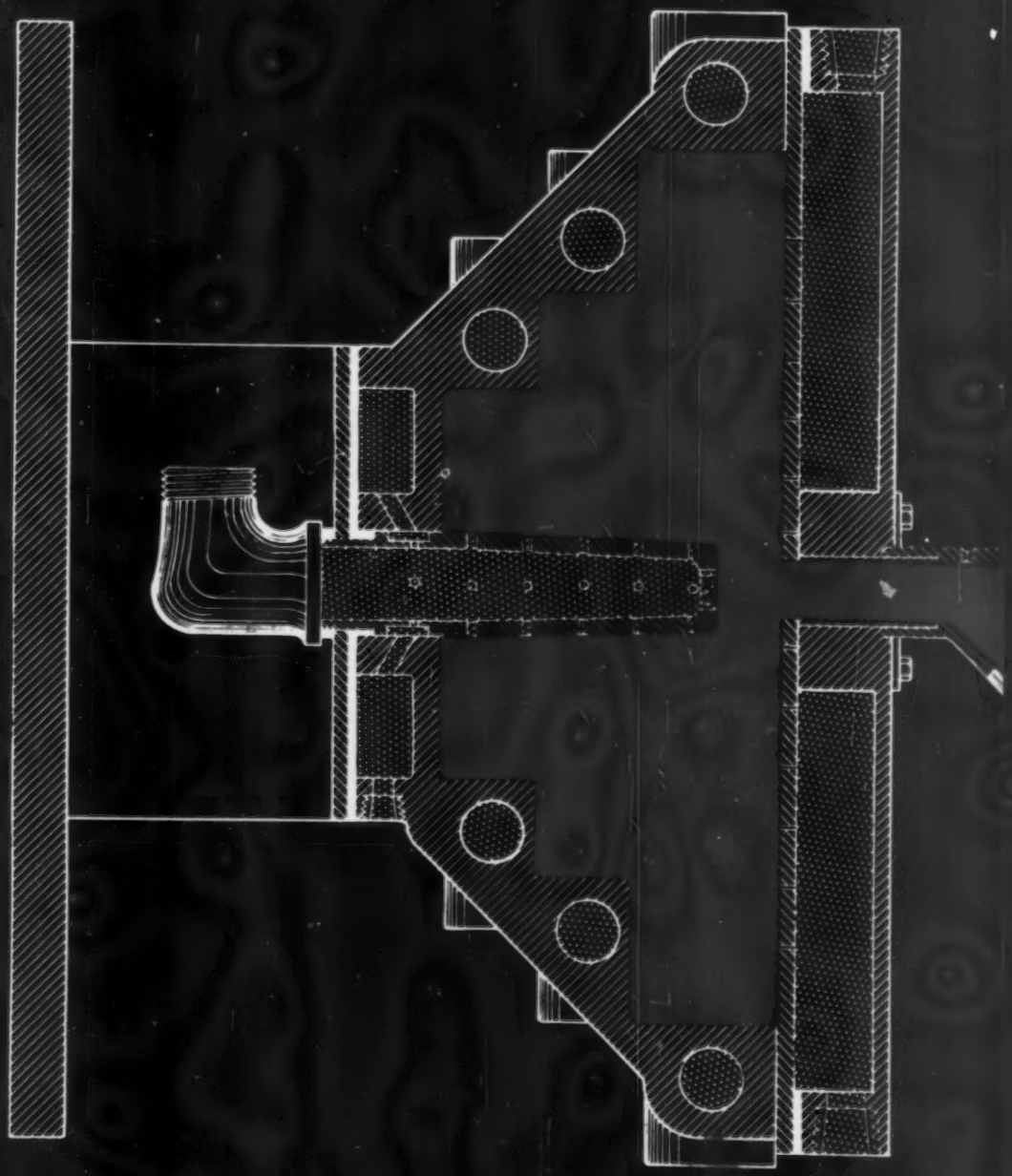

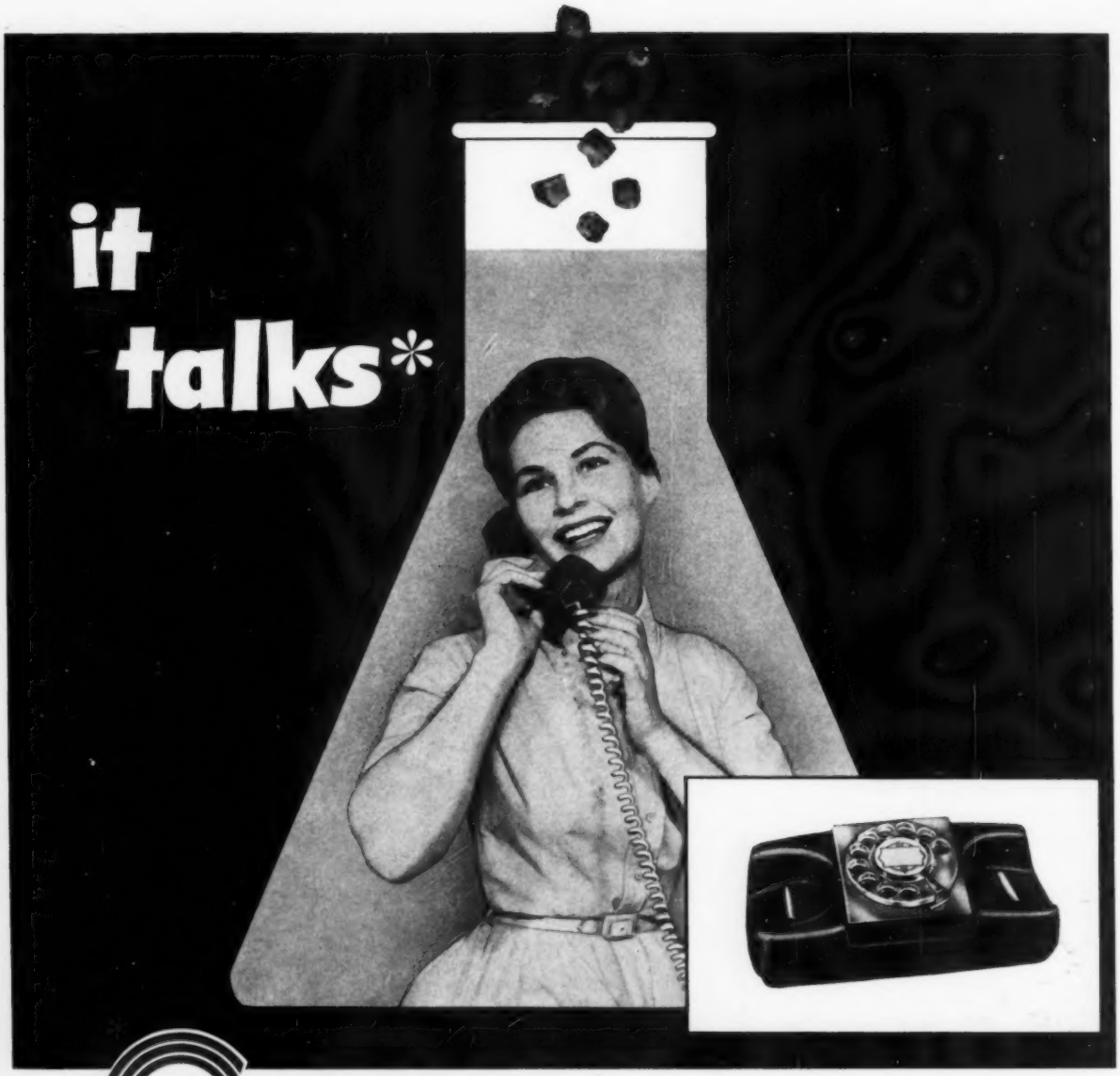

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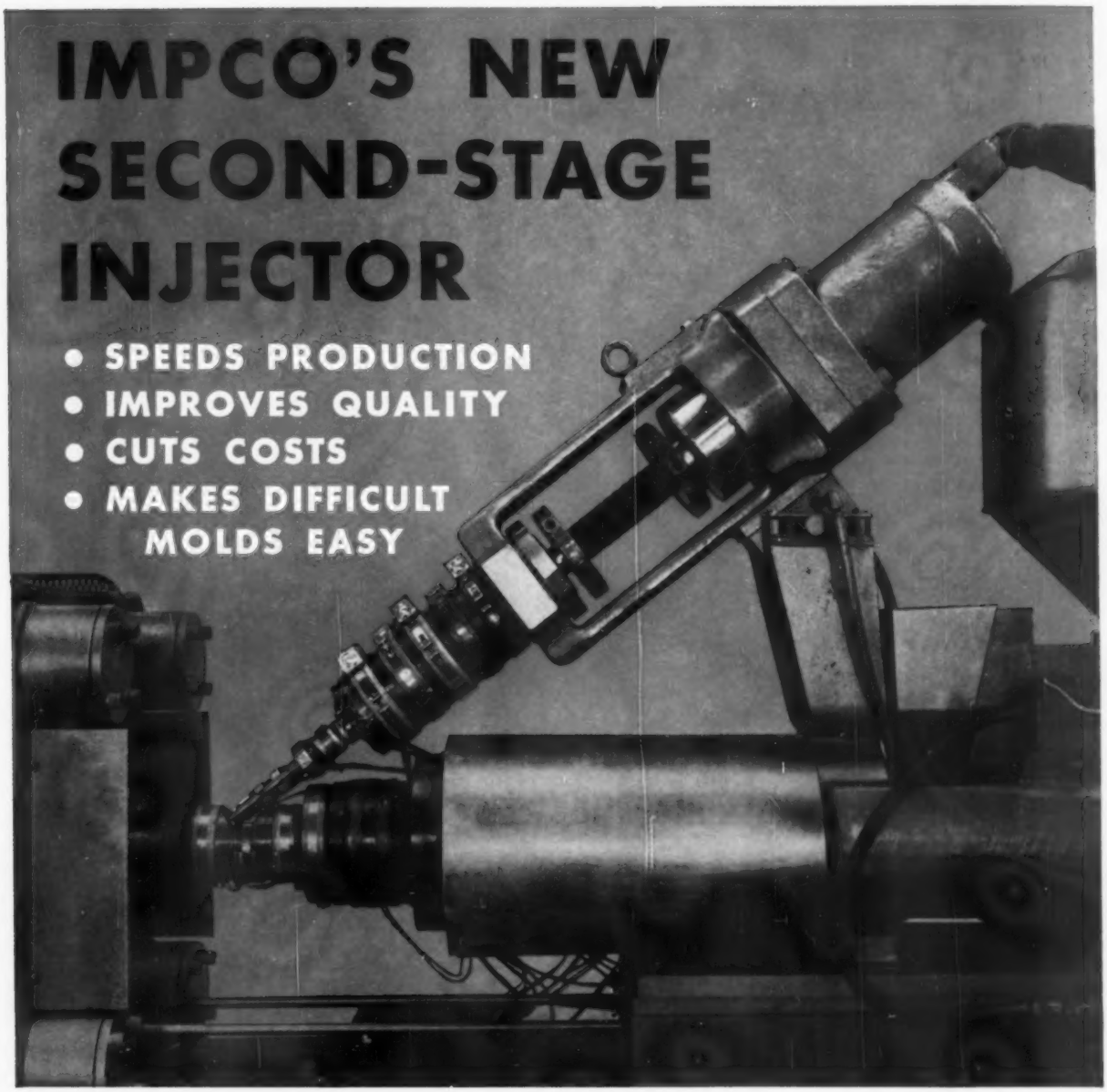

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PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

April 1961, Vol. 7, No. 4

feature articles:

the reco story-research and testing at the processor level ..... p. 25
by R. S. MORRISON
MFG has definitely demonstrated the value of its RECO test program in quality control and in materials and product development to cut time and costs in a competitive economy. Any project can be scaled to fit the user's needs and finances.

determining stabilizer efficiency-oxygen bomb vs. oven heating vs. milling ..... p. 29
by DR. B. BAUM & MRS. A. L. PERUN
While all three methods are suitable for high-temperature testing, the oven method is adaptable to low-temperature aging tests. Although set up for polyethylene, these methods could be adapted to studying vinyl stabilization.

casting polypropylene film ..... p. 35
by R. L. WIBBENS
Major processing variables in the chill-roll casting of polypropylene film and their effects on film properties and production rates are presented.

exploring fabrication techniques:

automating expanded polystyrene molding ..... p. 40
by L. J. ZUKOR
Automating expanded polystyrene molding.

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by HARRY T. DOUGLAS
Heavy profits in heavy laminates.

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by PAUL E. FINA
Are you a short run thinker? Continue your plastic education, try—Wisconsin.

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Cover courtesy:
Tronomatic Machine & Mfg. Corp.
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Now...Two new Fortiflex resins for NSF THIN-WALL PIPE

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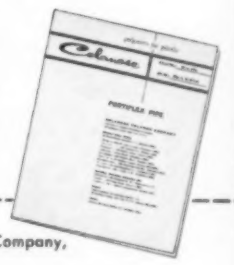

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Letters to the Editors

Comments on the classified tabulation

Sirs:

We sincerely believe that you have done a splendid job in compiling this information [machinery tabulation] and only have one or two comments to add. In addition to its standard models, Skin-Pak is in a position to quote on and build special sizes and special modifications of its general line of machinery. We would like you to ask us to revise our machinery specifications prior to your next publication date as we are continually adding to and refining our line.

Thank you for the summary and I look forward to receipt of the magazine.

Justin Field
Skin-Pak Machinery Co., Inc.
Paterson 3, N. J.

Sirs:

Your '61 tabulation on compression and transfer molding machines . . . is very, very good, and we are very appreciative of the space that you gave the Baker listing.

Offhand, I can see no particular way to improve this except possibly by including photographs from the individual companies. You might possibly be interested in policing this information a bit. We have been in the press business for many years and I frankly have never heard of half of these people that are listed in your tabulation. I also find that several of them that are listed as automatic press manufacturers definitely are not *automatic* press manufacturers. They may manufacture manual equipment, but to the best of my knowledge and I repeat—this is my business—they are not automatic press manufacturers.

Thank you again for publishing the Baker specifications.

N. W. Oberle
Plastic Press Division
Baker Brothers, Inc.
Toledo, O.

Sirs:

We felt that the presentation [on compression and transfer molding machines] was very comprehensive and factual, as it should be. We do suggest, however, that a little more emphasis be given to the role of the compression molding machine in the expandable polystyrene industry in any future articles . . . A breakdown of the type of material which can be used on each machine might well be included.

Mr. Zukor's article was quite well presented and very clear. About the only comment that we would offer is that we have found independent clock timer mechanisms to be more desirable than cam operated timers in the expandable polystyrene molding operation. Two basic reasons for this are: (a). When timers are arranged to operate in sequence, any one setting can be changed independently, without affecting the settings of the other factors; (b). Ease of replacement reduces maintenance cost, specially with the plug-in type timer.

Please accept our congratulations on this article and our thanks for this service to our entire industry.

Anton L. Lang
Springfield Cast Products, Inc.
Springfield, Mass.

Sirs:

Thank you for your comparative data sheet. We are very glad to have it and it seems to be quite complete from what we can see.

We did notice among the Wabash presses that nothing was mentioned about their building a large percentage of custom presses to customers' orders. The only thing you show is their production run presses. It would seem to us that easily 50% of their production is on specialty presses, ranging from slight modifications to completely job-designed presses. Nonetheless, we think it is well done.

Frank W. Fernholtz
Fernholtz Machinery Co.
Los Angeles, Calif.

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

On schedule

May is a special issue, centering around the Ninth National Plastics Exposition and SPI National Conference. The former will be held June 5-9 at the New York City Coliseum, the latter at the Commodore Hotel. These events are held but once every 2½ years, and what better opportunity does one have to view all the latest materials, processes, and equipment under one roof? It would take dozens of plant trips, telephone calls, and discussions with sales and technical service reps to accomplish the same end result. To those processor-owners who might contend that they cannot afford to attend, one might reply: "How can you afford not to?"

But mere attendance is not the answer. How does one attend an exposition effectively, getting the most out of his time and money? Even old hands at expositions (trade shows, if you like) confess to wandering around aimlessly (at times) just "looking at the sights." This is fine if you have the time—and strong arches, but let's be very practical for the moment.

We at PT are preparing a special section on the show. We will list exhibitors alphabetically by booth number. We will run a classified list by material or equipment. For example, if you are interested solely in vinyl extrusion—look under vinyl and under extrusion equipment for classified listing of exhibitors and their booths. We will carry the floor plans, with booths color-coded for material or equipment and letter-coded for interest to a processor; i.e., extruder, blow molder, vacuum former, etc.

The May issue will also feature an article by our engineering editor pointing up ways for planning and budgeting your time. This will be set-up by process, taking into consideration competition by other methods and materials as well as new or projected fields of interest.

Other articles "On Schedule" include the Ren Morse work on management considerations in injection molding, the Frimberger-Fuller story on single-screw injection,

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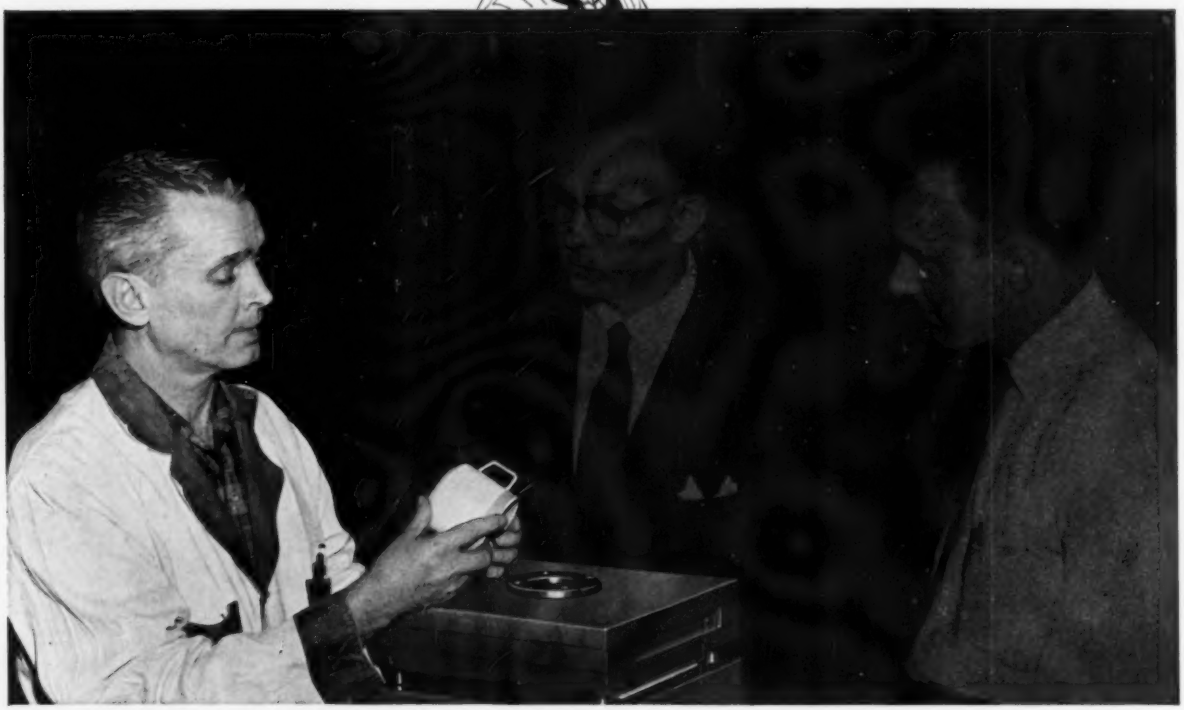

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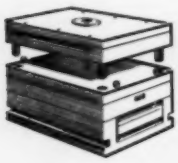

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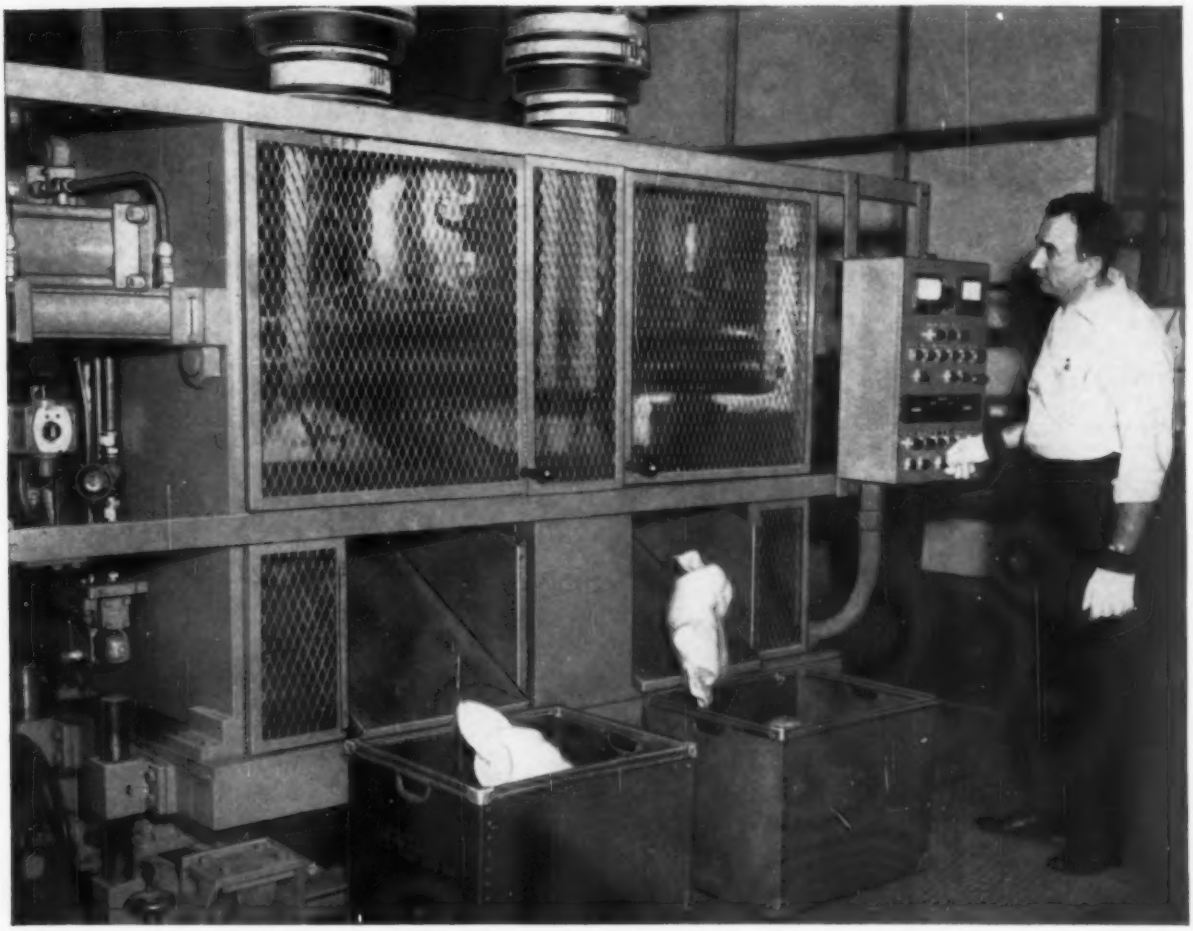
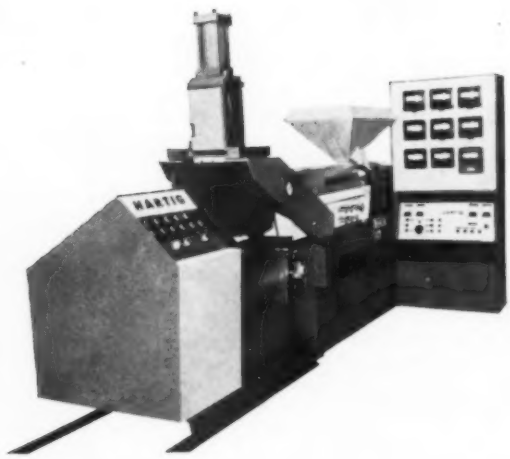


New Hartig blow molding press



in action at Ideal Toy. Shown above is one of the new Hartig blow molding machines producing doll bodies. Operation is continuous and automatic; output is of high quality and uniform; maintenance is simple. This press can handle parts up to 17-inch diameter, is track-mounted for easy mold changes and extruder maintenance.

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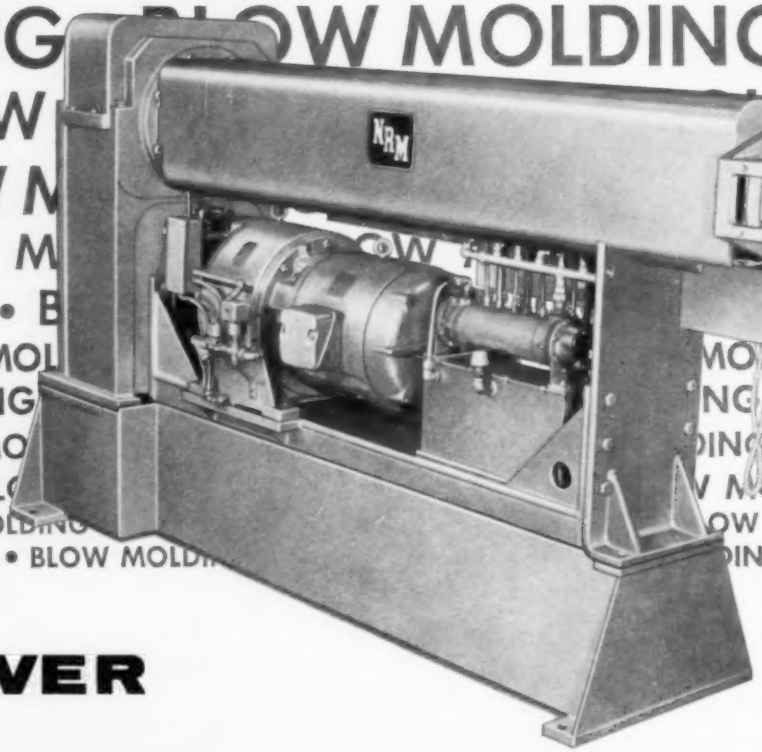

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Abstracts

"Production of Polyolefin Film and Sheet" by H. Domininghaus, Kunststoff-Rundschau, October and November 1960, details the characteristics of polyolefin film and sheet, methods and apparatus for working film and sheet, applications, and techniques for avoiding defects.

"The Extrusion Process" by R. Anguita, Revista Plasticos, September-October 1960, is the first in a series which covers principles of design, use of plastics machinery, and latest techniques developed by leading processors.

Patents

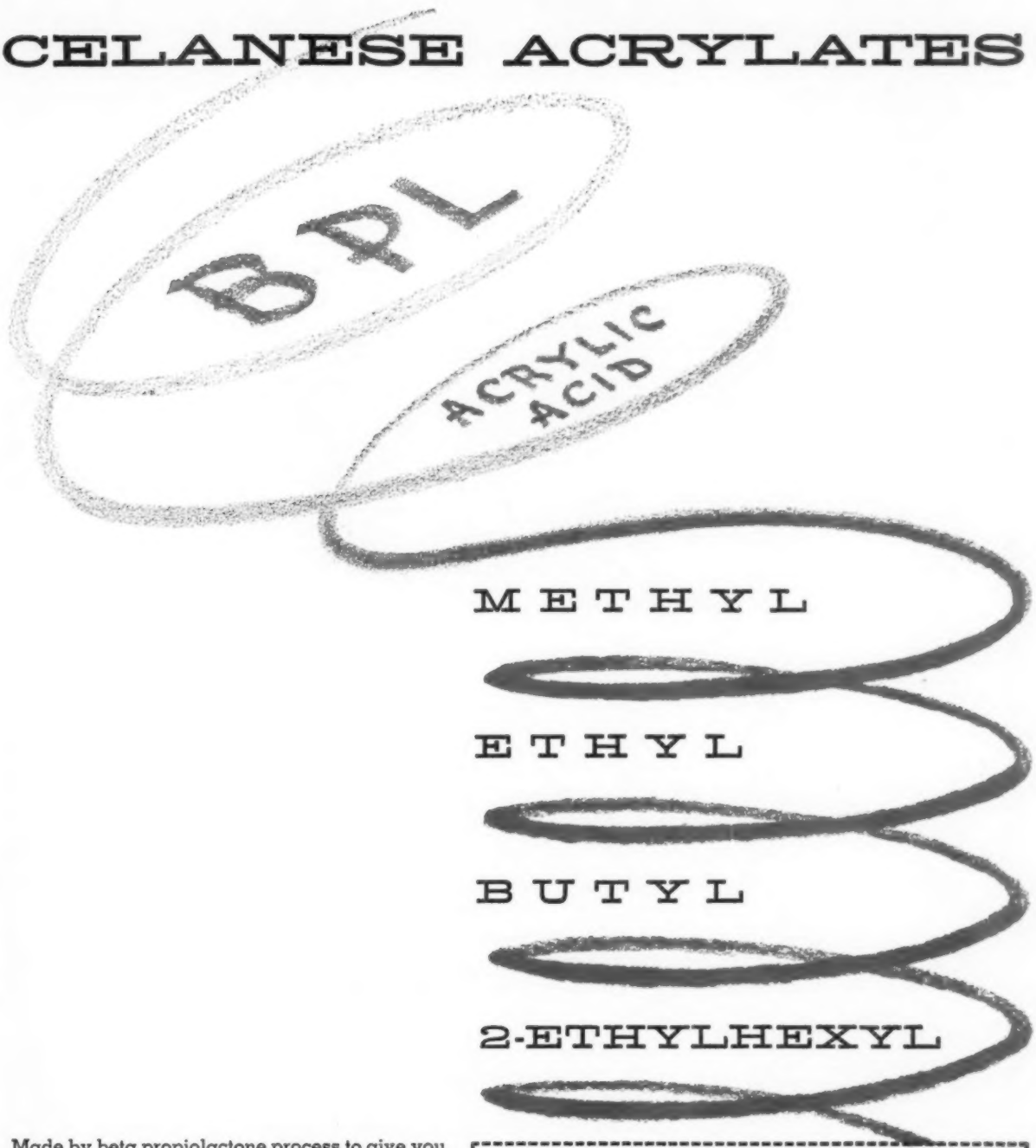
2,964,065 to Continental-Diamond Fibre Corp, Newark, Del. A method for forming polytetrafluoroethylene tubing with great circumferential strength and the ability to withstand crimping without splitting or cracking.

2,908,941 to General Motors Corp: Method of molding a ball-like article with an opening. A thin core of material is molded about a metal tube to make the opening. The entire structure is moved to a larger mold for adding of the external material, after which the metal insert is removed.

2,908,942. In injection molding plastic flowers and leaves in multicolor design, the leaves are molded first. Portions are then cut out, and the spaces subsequently filled with material of different appearance.

2,908,943. Process for molding two-layer polyurethane articles, such as football helmets, of foams of different densities and characteristics. The first piece is soaked in a salt bath and perforated. Mixture for the second layer is poured on top. The article is air gelled, cured, and removed from mold before a post curing of about five hours at 250° F.

CELANESE ACRYLATES



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Celanese Chemical Company is a Division of Celanese Corporation of America.

Celanese Chemical Company, Dept. 564-D,
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HERE IS THE MOST EFFICIENT, NON-TOXIC PLASTICIZER MADE

Harchem Dibutyl Sebacate has been FDA approved as a non-toxic plasticizer for food wraps. Equally important, it has been user-approved for the following reasons:

Compared with other plasticizers for food wraps, Dibutyl Sebacate offers . . .

Best Low Temperature Properties . . . Best Heat Stability in Terms of Discoloration and Odor . . . Lowest Degree of Tack . . . Low Initial Viscosity for Plastisols . . . Contributes to Thixotropic Properties

	DIBUTYL SEBACATE	NON-TOXIC PLASTICIZER X	NON-TOXIC PLASTICIZER Y	NON-TOXIC PLASTICIZER Z
Efficiency Level to obtain equal moduli (parts per hundred)	39	52	54	53
Low Temperature Flexibility Tf °C @ 135,000 psi	-36.6	-22.8	-24.8	-15.7

Whether judged on a basis of performance or cost, you'll find Harchem **Non-Toxic Dibutyl Sebacate** a superior plasticizer for food wraps.

Write for Data Sheet

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HARCHEM DIVISION

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IN CANADA: HARCHEM LIMITED, TORONTO

U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

APRIL, 1961 — U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation — 99 Park Ave., N. Y. 16, N. Y.

Packaging Notes

Liquid-tight carton with built-in liner of polyethylene-coated paper requires no overwrap. Heat sealing, hot-melt

Wrapless frozen-food carton developed on West coast has polyethylene-coated paper liner which interlocks with flaps on folding. Subsequent heat sealing and gluing complete liquid-, vapor-tight closure.

adhesive and unique design of package all contribute to leak-proof closure. It has proved commercially acceptable for packaging frozen strawberries.

According to the company adopting it, this folding box and special integrated machine which opens, fills and seals it have boosted production speed substantially. Furthermore, it reportedly costs less, is easier to open and provides a better barrier to transmission of water vapor than the metal-end fiber can it has replaced.

Polyethylene squeeze bottles for cosmetics, and toys and Christmas ornaments are now being finished by a new vacuum

metallizing process. Result is an adherent metallic coating—with a texture—which reportedly withstands many squeezings and takes printing without pre-treatment. A choice of colors is available.

According to the developer, process is competitive in cost with ordinary plastics metallizing.

Clams-in-the-shell have joined the growing list of polyethylene-packaged, individually quick-frozen foods. Whole frozen clams are now available on the west coast in 7½" x 13", 3-mil polyethylene bags. According to the marketers, polyethylene was selected for packaging because "it is relatively inexpensive and controls breakage."

DO YOU HAVE a new polyethylene product or development you'd like the industry to know about? Make it routine to send your information on new developments to U.S.I. POLYETHYLENE NEWS.

Address:
U.S.I. POLYETHYLENE NEWS, U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corp., 99 Park Avenue, New York 16, N. Y.

U.S.I. Announces Plans to Produce Linear Polyethylene

Will Build 60,000,000 Pound-Per-Year Plant at Houston, Texas

U.S.I. will begin construction this Spring on a 60 million pound-per-year linear polyethylene plant at Houston, Texas, adjacent to the company's conventional polyethylene facilities. The new plant, which will mark U.S.I.'s entry into the manufacture of linear polyethylene, is scheduled for completion in the fourth quarter of 1962.

Recently there has been considerable discussion about over-capacity in the linear polyethylene field. Dr. Robert Hulse, general manager of U.S.I., states: "We would not be building this important new plant if we did not believe that over-capacity is a short-term problem and that linear polyethylene is growing in importance. Every market projection we have made indicates that this versatile plastic will be in short supply by early 1963."

PETROTHENE® Trade Name to Be Used

The new U.S.I. plant, designed for easy expansion, will be managed by the same people who are now running the low and medium density polyethylene plant at Houston. The linear polyethylene will be manufactured under a licensing agreement with Phillips Petroleum Company, and will be sold under U.S.I.'s trade name, "PETROTHENE®" polyethylene resin.

Linear polyethylene is stronger and more rigid than the conventional type. It is widely used for blow-molded bottles and containers for industrial products, detergents and other household staples. Other growing markets include injection molded items such as toys and housewares; extruded pipe; and film for heavy duty bags and similar products.

Company Makes Wide Range of Resins

U.S.I. facilities for conventional polyethylene have a rated capacity of 300 million pounds annually. The company currently produces some 100 types of 36 basic low and medium density resins at plants in Houston and Tuscola, Ill. Linear resins are also currently available from U.S.I. pilot plant facilities and through resale arrangements.

New Resins, Equipment Featured By U.S.I. at Packaging Exposition

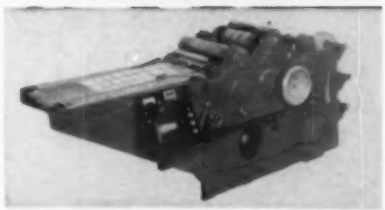
An array of packaging, injection molding and bag-making machines *in action* will be U.S.I.'s main attraction in Booth 1112 at the 30th National Packaging Exposition, April 10-13, at Chicago's Lake Front Exposition Center.

In operation will be three See-Safe packaging machines, which automatically package objects in polyethylene film from slit roll stock. This lineup will include: the Model MA, packaging free give-away items; the MA Jumbo, packaging large products in one step; and the brand new MA-T tilt-top machine, pouring and packaging small parts.

New Bag Making and Injection Molding Machines

Two Conapac machines will also be featured. The "Roto Poly-200", a high-speed heavy-duty machine, will be making bags from blown polyethylene tubing. It has a capacity of up to 200 cycles/min., operates at speeds up to 175 ft./min., and is reportedly the first which can handle *any* density polyethylene film. The "Rotojet" Model T5 will be injection molding small polyethylene containers. Said to be the first rotating turret type machine to appear in this country, it operates at speeds up to 50 shots/min., uses 8 single-cavity molds.

For extruders, converters and packagers of produce, soft goods, hardware or toys, the highlight of U.S.I.'s exhibit will be a new PETROTHENE polyethylene resin. Film extruded from it *combines maximum clarity and gloss with high impact strength, and offers optimum performability as well.* Samples and complete technical data will be available



The See-Safe MA automatic packager (top) and Conapac Roto Poly-200 bag maker are 2 of 5 new machines U.S.I. will feature at the show.

for this and all other PETROTHENE resins.

On display, too, will be samples of polyethylene-coated kraft, foil and cellophane. And, a variety of containers—including bottles produced from new PETROTHENE blow-molding resins. Of particular interest will be the 5-gallon collapsible jug just put on the market.

U.S.I. technical representatives will again answer questions and talk over polyethylene packaging innovations. Visitors are urged to use this opportunity to get expert help on specific problems.

Joe Foster, President, suggests the range of Foster Grant's engineering services.

"Help design molds for a customer? Sure, and we can production-prove them for you, too," says Joe Foster.

Not that designing molds is our business.

Basically, we're suppliers of polystyrene, impact polystyrene and Nylon 6 resins, and we're also the world's largest manufacturer of sunglasses. But quite often a customer takes us up on our standing offer — of technical assistance in any area, from materials and machines to packaging and marketing.

Take last Fall, for instance. One of our customers was in Leominster, so we invited him to drop over and see our facilities. He molds combs, and one glance convinced him that some of our ideas might make his operation more productive.

We then offered to furnish him an improved mold, designed for his needs and tested by us **on his own machines.** Result — he now gets 16 combs per "shot" instead of 8, semi-automatic instead of hand de-gating, and a 26% shorter cycling time. No more grinding or buffing, either... for a yearly saving of more than $100,000!

Why not see if our engineering services can help **you.** Call or write us today. Foster Grant Co., Inc., Leominster, Mass., KEystone 4-6511.

FG®

FOSTER GRANT

Your Partner in Plastics Progress

Plants in Leominster, Mass., Manchester, N. H., Baton Rouge, La.
Branch Offices and Warehouses in principal cities
Also distributed by H. Muehlstein & Co., New York, N.Y.

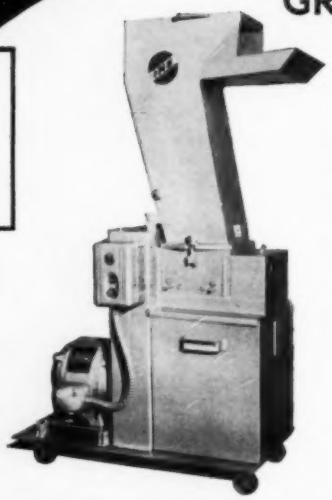
INJECTION MOLDERS!

BOOST PRODUCTION!

M-3 IMS M-4 GRANULATORS

All machines illustrated here in stock for

IMMEDIATE SHIPMENT



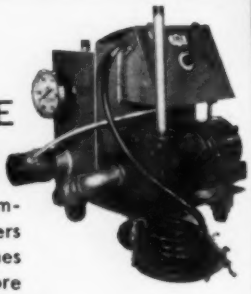
The IMS M-3 6½" x 7" throat sprue grinder — rugged — simple in design — easiest to clean — built-in throat clearance bar — casters — catch pan.

PRICE: Complete with 1 HP Motor and Starter --- $628.50
Same, but with 2 HP Motor ------- $678.00

The IMS M-4 5⅜" x 8½" throat grinder — designed primarily for vinyl, polyethylene, plastisols and all elastomerics where a fine-free low bulk factor product is desired — large throat for large injection molded parts.

PRICE: Complete with 2 HP Motor and Starter $815.00
Same, but with 3 HP Motor $878.00

LOW COST "MIDGET" TEMPERATURE REGULATOR



Duplicates performance of mold heaters costing up to 6 times as much... new more compact model with closed circuit ends mold rust... cuts your water bills! Temperature range 50° to 250°... Portable, only 15" x 22½" floor space.

PRICE: Complete ------ $391.50

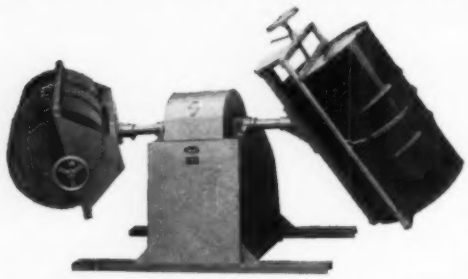
FREE BULLETIN ON REQUEST

Send for our Nozzle and Plant Equipment Catalogs Today! You'll find all IMS stock injection plant accessories fully described and priced.

Prompt service on all kinds of nozzles and heating cylinders by the world's largest and most experienced nozzle and heating cylinder redesign specialists.

IMS DRUM TUMBLERS

FOR ALL COLORING AND MIXING OPERATIONS



¾ HP Model ---------- $675.00
(Takes drums up to 33" high x 22" in diam.)
1 HP Model --------(same as above)-------- $788.50
2 HP Model ---------- $927.50
(Takes drums up to 37" high x 23¼" in diam.)
3 HP Model ---------- $1285.00
(Takes drums up to 43" high x 24" in diam.)
5 HP Model ---------- $2650.00
(Takes drums up to 45" high x 24" in diam.)

ORDER TODAY.
FREE BULLETIN ON REQUEST

INJECTION MOLDERS SUPPLY CO. INC.

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CLEVELAND 28, OHIO

New member of the Oncor® family–23A...

A unique pigment for flame retardance in halogenated plastics and paints

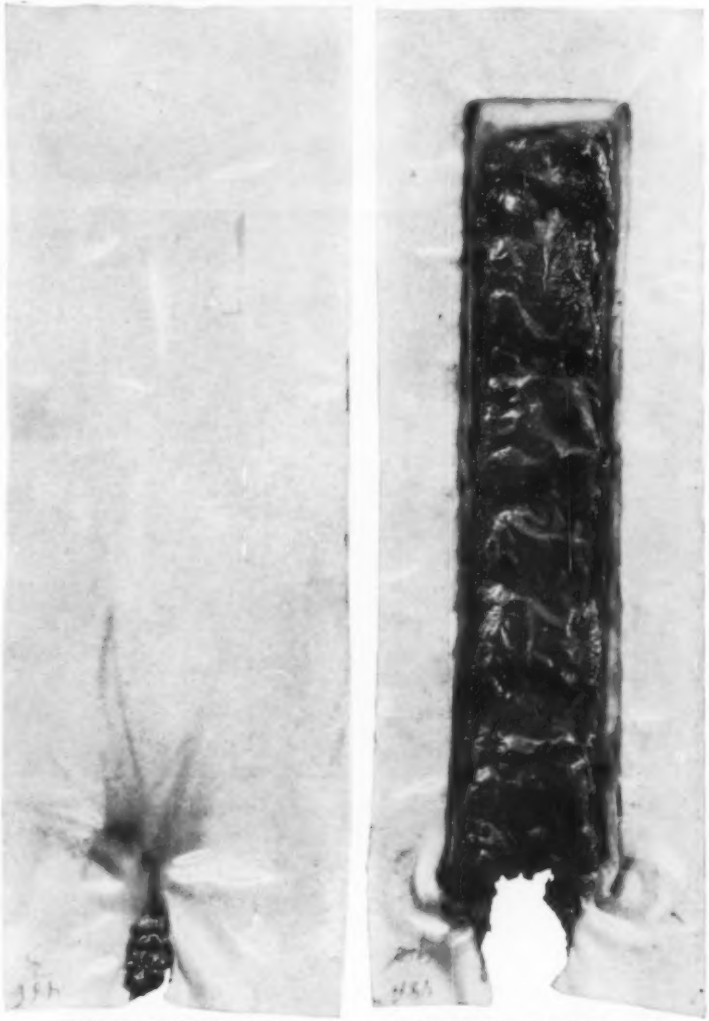
Never before has there been a pigment like ONCOR® 23A, developed especially for compositions based on halogenated resins. This pigment is composed of an inert silica core of low specific gravity, and has a surface layer of antimony oxide fused to the core.

Here's a quick run-down on the outstanding features of this significant new ONCOR pigment:

1. **Effective Flame Retardance** – ONCOR 23A pigment compares favorably with conventional antimony oxides in flameproofing efficiency in halogen-containing resins for plastics and paints. In tests on vinyl films, ONCOR 23A pigment has given equivalent flame resistance compared to conventional antimony oxide, on an equal weight basis.
2. **Low Tinting Strength** – ONCOR 23A pigment has a low and uniform tinting strength. In vinyl film tests, tinting strength consistently measures between 60% and 65% of a conventional antimony oxide standard. This allows most effective use of colorants.
3. **Low Specific Gravity** – Because of its special physical structure, ONCOR 23A pigment has a lower specific gravity than regular antimony oxides. This means a higher volume yield per pound of pigment.
4. **Excellent Dispersion Characteristics**—as a result of careful production controls, ONCOR 23A pigment has a particularly uniform particle. This assures consistently good dispersion in both plastics and paints.

ONCOR 23A pigment is suggested for use in all halogenated plastic and paint compositions requiring flame resistance. It may be used with polyvinyl chloride, vinyl chloride copolymers, chlorinated paraffins, chlorinated rubber, chlorosulfonated polyethylene, chlorinated polyesters and the commercial fluoropolymers.

Additional information on the new ONCOR 23A pigment is provided in the National Lead Company Data Sheet just off the press. The handy coupon at the right will bring you a copy by return mail.



WITH ONCOR 23A **WITHOUT ONCOR 23A**

These two samples show typical flammability test results on vinyl film, following the procedure specified in ASTM D-1433-58. (See Item 1 in text.)

KC-6295

NLC

National Lead Company: General Offices, 111 Broadway, New York 6, N.Y. In Canada: 1401 McGill College Avenue, Montreal.

Gentlemen: Please send your new Data Sheet for ONCOR® 23A, antimony silico oxide pigment for flame retardance in halogenated plastics and paints.

Name _____ Title _____

Company _____

Address _____

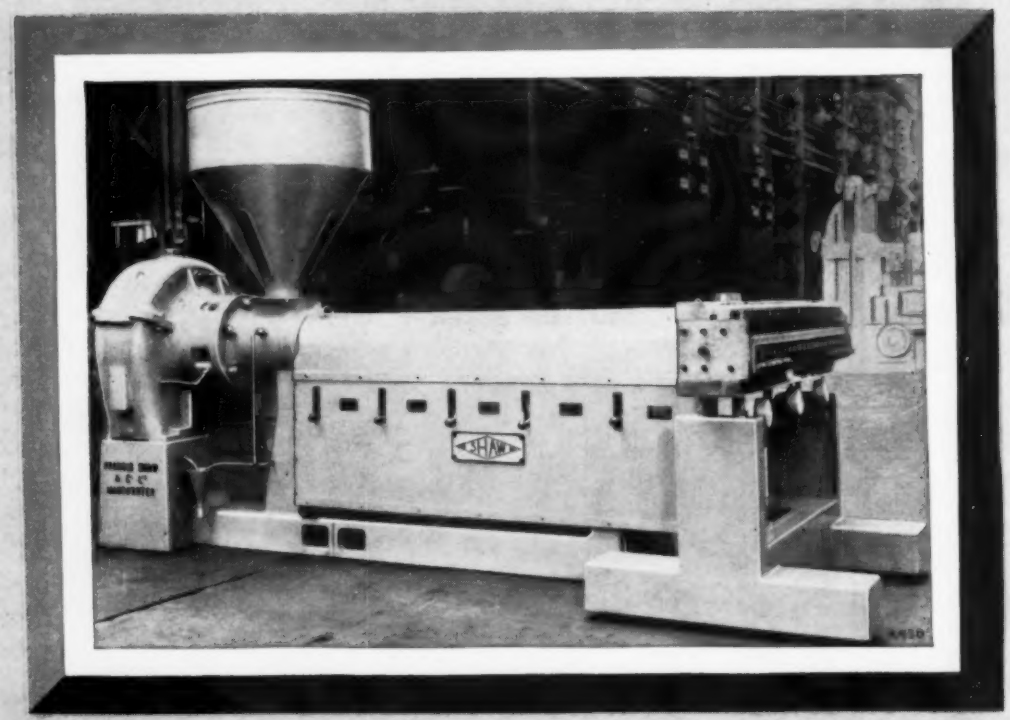
City & Zone _____ State _____

23A *an* **oncor®** *Pigment...A Development of* **National Lead Company**

General Offices: 111 Broadway, New York 6, N.Y.

behind every *Francis Shaw* machine

research – design – quality engineering



The new Francis Shaw P.4½" extruder for high impact polystyrene sheeting represents a completely modern approach embodying all the latest techniques.

Constant research and development, close co-operation with users, advanced design, selected high quality materials . . . These, coupled with long experience, help to create processing machinery of unrivalled performance.

* Designed for easy maintenance and long life
* Direct heating of cylinder and diehead through separate zones
* Electronic temperature proportioning for sensitive and precise control

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OVERSEAS AGENTS THROUGHOUT THE WORLD

PM553

Editorial: Need for price stabilization

If there's any truth in the adage "misery loves company," we should all feel a lot better. The same problems which have been plaguing the American plastics industry are beginning to be felt abroad. Their biggest problem, according to latest reports, is the uncertainty of material prices. Sound familiar?

In Europe, practically no processor will keep an adequate inventory of material. Prices fluctuate to the point of being completely absurd. Processors have been giving ridiculously low quotes on a job; then, shopping around until they find a supplier willing to meet the correspondingly low price at which they must obtain their material. They, too, are beginning to view the matter as a vicious cycle.

Whether at home or abroad, one thing is certain. Markets cannot be extended beyond the saturation point. When every housewife who can be sold has her full complement of plastic housewares, she will require only occasional replacements. She will buy an item which seems better; conversely, she won't replace inferior products. Cutting material quality can destroy an established market, and price cutting goes hand in hand with quality cutting. It can't be otherwise.

Everyone loves bargains, but most of us realize that they are "a sometime thing." It is *not* always necessary to cut prices in order to sell. Quality merchandise at *fair* prices, along with a sound advertising and sales program, has always moved.

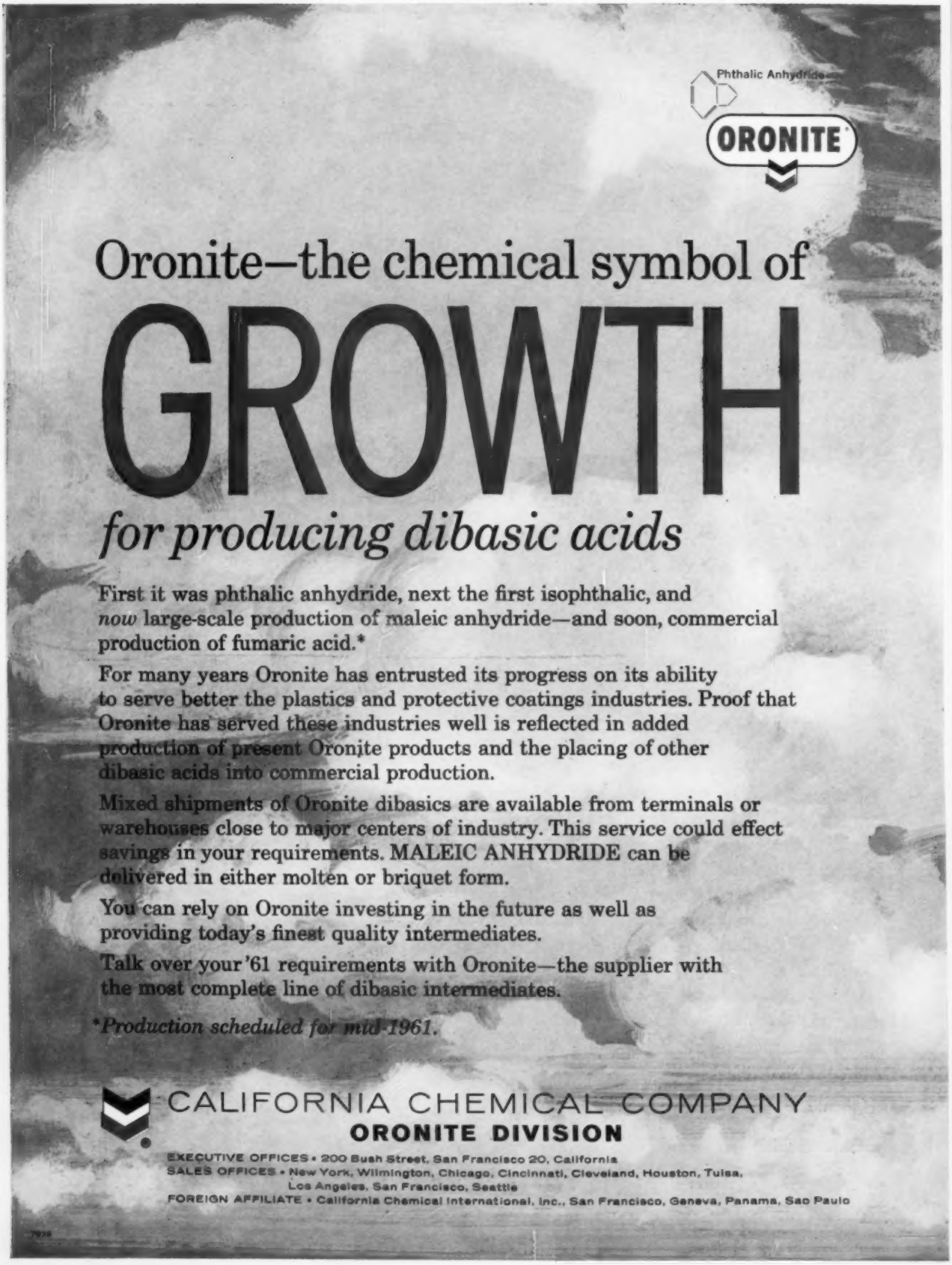
The plastics processor prefers to sell at a fair rather than cut-rate price. Cutting prices also cuts profits in the long run, and makes it almost impossible to run a sound business.

There is much agitation in Europe for a fixed price structure. In the case of polyethylene, it has been suggested to establish prices based on molecular weight. This was felt fair since the high melt index, low molecular weight, film forming grades tend to depress prices. This slack is then taken up by the high molecular weight resins.

Fair prices should be based on an overall program. Factors which must be taken into consideration run the gamut from research, testing, amortization, salaries, and overhead to advertising, sales, and profits. Price cutting takes from them all.

Jim Regan

Editor


Phthalic Anhydride
ORONITE
Oronite—the chemical symbol of
GROWTH
for producing dibasic acids
First it was phthalic anhydride, next the first isophthalic, and now large-scale production of maleic anhydride—and soon, commercial production of fumaric acid.*
For many years Oronite has entrusted its progress on its ability to serve better the plastics and protective coatings industries. Proof that Oronite has served these industries well is reflected in added production of present Oronite products and the placing of other dibasic acids into commercial production.
Mixed shipments of Oronite dibasics are available from terminals or warehouses close to major centers of industry. This service could effect savings in your requirements. MALEIC ANHYDRIDE can be delivered in either molten or briquet form.
You can rely on Oronite investing in the future as well as providing today's finest quality intermediates.
Talk over your '61 requirements with Oronite—the supplier with the most complete line of dibasic intermediates.
*Production scheduled for mid-1961.
CALIFORNIA CHEMICAL COMPANY
ORONITE DIVISION
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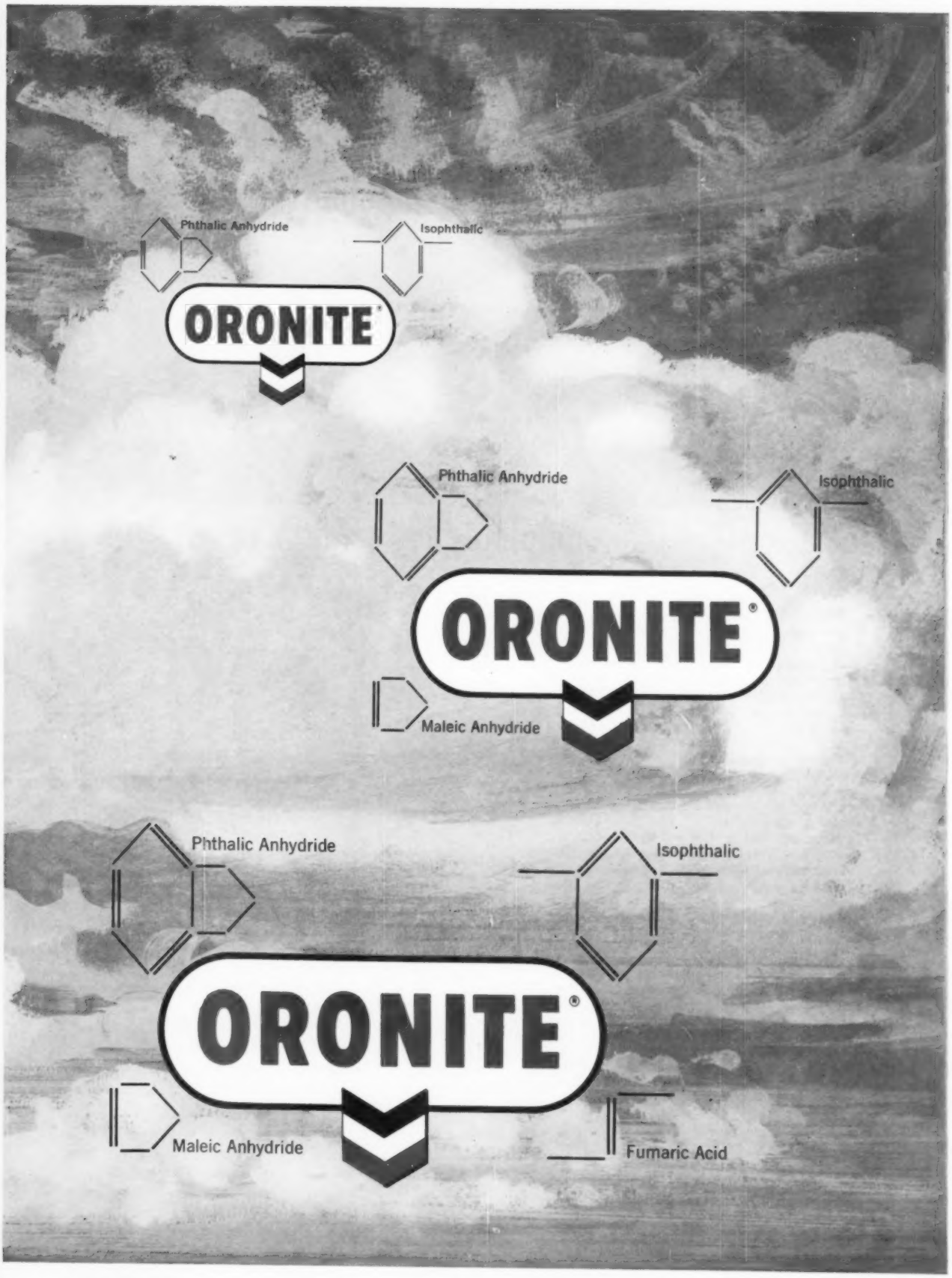
FOREIGN AFFILIATE • California Chemical International, Inc., San Francisco, Geneva, Panama, Sao Paulo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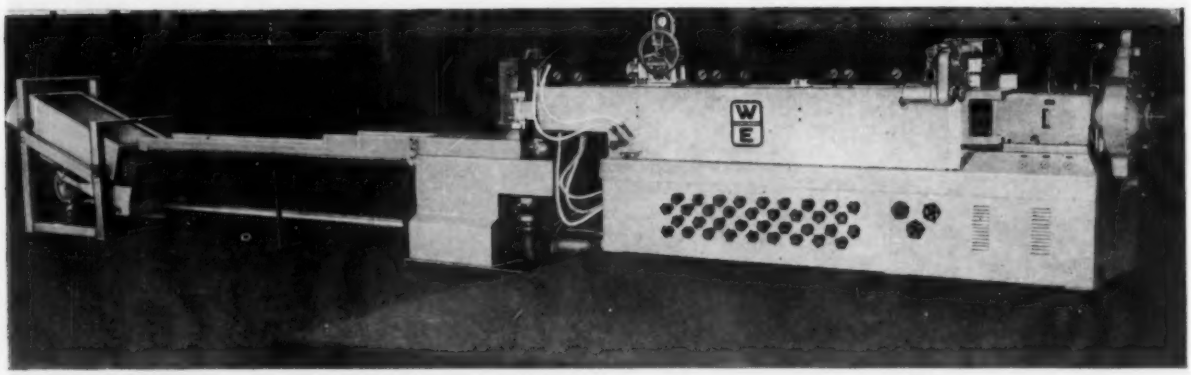
A problem story and its Solution

for high rate manufacture of High Quality

polypropylene and high density polyethylene

Welding Engineers dual worm compounder-extruder in



association with a complete hot pelletizing system

When all the engineering chips are down and the profit eye is in perfect focus on the end product . . . the *ability* of the tools of production in the manufacture of these important thermoplastics cannot be denied. If teamwork pays off with the thinking power in your organization . . . it does the same thing to an even greater degree in the mechanical teamwork in your plant. *Consider:* Quicker, easier start-up, non-touch flow of material from feed to shipping, independent speed control for quality control in thru-put . . . and the kind of end-product worthy of your sales and engineering effort. This complete Welding Engineers system includes the proper custom-fitted compounder-devolatilizer-extruder for your particular application, uniform cutting with non-submerged type die, and improved water sluice and drying conveyor combination.

RATE: 2300 pounds per hour and more is the production experience of some of the outstanding producers of polypropylene and high density polyethylene. We have the accumulated experience to make an investigation of the advantages of Welding Engineers complete hot pelletizing system well worth your while.

WRITE—WIRE—PHONE Welding Engineers research, engineering and technical sales people serve every important plastics manufacturing area world-wide • Main offices and plant: Norristown, Pennsylvania • Telephone BRoadway 9-6900 • Exclusive Sales Representatives for Europe and the British Isles, Welding Engineers Ltd., Geneva, Switzerland • Far East Sales Representatives, Marubeni Iida Co., Ltd., Tokyo, Japan.

PLASTICS
THE MAGAZINE OF APPLIED ENGINEERING
TECHNOLOGY

The RECO story— research and testing at the processor level

By running this article, we are not suggesting that every processor go right out and set up an expensive research and testing program. Far from it; however, some evaluation of material and processing variables is vital to cut time and costs in a competitive economy. Any project can be scaled to fit the user's needs and finances. Mutual cooperation put the steel industry where it is today. Check your technical publications carefully for pertinent data; attend technical meetings and discuss your problems; and use your ingenuity to set up your own system of controls and data files. Remember, you can't expect the suppliers to do all the work for you and still lower the prices of raw materials. —Editor.

R. S. MORRISON*

Variety is, and will remain, plastics' greatest advantage—but, also, their greatest problem. How, out of the welter of different materials, different combinations of materials, different processing techniques, can a manufacturer or designer best be assured of the right answer, in plastics, to his product requirements?

There is tremendous room for improvement in current plastics production and products—hundreds of areas where research and testing on production materials, methods, and products can not only be valuable, but essential. However, in the absence of regular programs of critical study at the "point of manufacture," the need and possibility for such improvements can well go undiscovered.

For the most part, plastics research and testing have been left to the material supplier. Molders have too often relied on specification sheets and other company literature to furnish all the information required of a particular job. No matter how conscientious these suppliers may be, it is only natural that they play up their material's strong points and avoid too much mention of its drawbacks. Then, there is the question of performance under actual shop conditions which may be somewhat less than ideal. And what about consistency of results?

More importantly, most test work conducted by material suppliers centers around their specific products. Published information is limited, in great part, to data proving their materials' performance superior to competition. One can hardly expect a profit making organization to do otherwise, but we are left with something less than all the facts. Since most materials companies are large, liaison between test and technical service personnel can be tenuous. It has also been our experience that many companies restrict the flow of information from laboratories to their sales force, thus keeping new developments from leaking out before production is set.

Perhaps this is not so serious in the case of molders who buy an already polymerized material and make only a physical change in its shape or structure. Where chemical changes are involved, however, the possibilities of variations in physical and other properties of an end product are far greater.

On the production side, it is surprising how much improvement can be made in molding techniques and quality when expected product standards are clearly defined on the basis of tests. Research and testing at the processing level offer a clear solution. It is at this level that all material and processing variables come

*President, Molded Fiber Glass Companies, Ashtabula, O.

R. S. Morrison

together; here, that the effect of their interaction can actually be observed and evaluated.

For this reason we, at the Molded Fiber Glass Companies, decided to set up yet another company—RECO, devoted exclusively to research and testing for the associated companies. We have invested around $150,000 in capital equipment and facilities, and this year's budget calls for $120,000 in operating expenses plus $30,000 for additional equipment. We could spend twice that much in both areas—if we had it. Too, it takes time to develop both personnel and programs.

RECO has been in operation for four years—profitably, we feel. I am convinced that there can be no standing still. A molder who does not improve will go backward while his competitors advance. Without an adequate program of research and testing at the molder's plant, it is impossible to determine the effects of all the material and processing variables and take steps to control them. Only in this way can the optimum desired properties be obtained, and obtained consistently.

The reinforced plastics industry has had considerable difficulty in developing meaningful quality standards. There are innumerable variables including not only resins, reinforcements, pigments, fillers, and catalysts —but also different structures, radically different molding techniques, different pressures, temperatures, and timing. Since every element has a critical effect on product performance, ingredients and processing methods must be evaluated in terms of end-use requirements. Such testing establishes sound manufacturing techniques and final production-line quality control.

RECO's six specific objectives

1. Find the best materials for each specific product, whether proprietary or custom. This may involve only a choice of standard resin and reinforcement, or it may require resin modification or even development of a new resin.

2. Find the best molding technique. Each product presents individual requirements and processing problems, and the laboratories help to determine the optimum molding temperature, cure time, pour pattern, and assembly and finishing techniques.

3. Ensure stability of the product in its proposed end use. It might be found, even at this early stage, that a part needs special reinforcement, thicker section, veil, special resin, filler, pigment, or special molding techniques.

4. Materials quality control for all components. Every shipment of reinforcement, resin raw material, resin, pigment, or filler is tested to ensure that it meets specifications. MFG manufactures most of its own resins in a local plant, and samples from every batch go to the laboratories.

5. Product quality control. Actual production parts are taken periodically from the processing line and subjected to thorough testing. By this, we determine whether parts will meet end use requirements and give satisfactory service.

6. Develop a data file of test information. This permits MFG engineers to select quickly the combination of materials and construction likely to meet a product specification. It serves as a time-saving guide, although special tests are run to determine whether the materials selected are best for the current project.

The overall research objective is to improve materials and production techniques for fiber glass plastics.

Actual test facilities

RECO has four laboratories: Chemical, Exposure, Physical Testing, and a special project section called the Endurance and Mix Lab. In addition to the many conventional tests, RECO has devised special tests for materials and products used in reinforced plastics. In some cases, we have designed and built special test equipment.

Chemical Lab

The Chemical Lab is concerned with the development and quality control of materials. It seeks constantly to develop new resins with favorable production characteristics and required end use properties. For example, it has provided the MFG Tray Co. with an isophthalic-type resin which offers rapid cure and far better exposure resistance at no sacrifice in physical properties. It is, of course, completely free of odor for use in food trays. For MFG Body Co., it produced a strong, tough resin which can withstand the heat of baked enamel finishing with minimum shrinkage.

Experimental resins are produced in a 2-gallon metal reactor. An effort is made to keep total production time under 16 hours so that a batch can be delivered every day with a staff on a two-shift basis. A 2-quart glass flask is used for small experimental batches, and a 5-gallon reactor was recently put in operation.

Uniformity is a prime objective in the quality control testing of materials. Greater mechanization in reinforced plastics processing makes it increasingly important that a resin remain uniform from batch to batch.

All materials to be tested, whether for development, product evaluation, or quality control, are molded into test panels using matched metal dies. For this purpose, RECO has three 50-ton presses and makes four types of panels: 12 x 12-inch and 9 x 9-inch flat panels; 12 x 12 x ⅛-inch lapstrake panels; and 12 x 12-inch corrugated panels. The presses are equipped to permit close control of temperature in the 200-300° F.

range. This enables the lab to check the effects of different molding temperatures on the materials under test. From 2-4 identical panels are made, one for the files and one or more for testing. In the panel preparation room, the text panels are cut into samples of exact dimensions using saws, grinding wheels, and a milling machine.

Physical testing lab

All samples are subjected to five standard tests for flexural strength, Izod impact, flexural modulus, tensile strength, and 180° F. Modulus. The sample is kept in a hot oil bath for three minutes, after which a 2-pound weight is applied while it is still in the bath. Deflection readings are taken after 10 and 100 seconds. Flexural strength and modulus tests are rerun after samples have been boiled for 2 hours. All samples get a Barcol hardness test which indicates completeness of cure, and there are two machines for fatigue testing. MFG engineers are working at present to determine design requirements based on strength and fatigue tests.

The reverse impact test, run on all veiled panels, has particular significance for the MFG Body Co., in the production of the Chevrolet Corvette, the White truck cab, and other automotive body parts. The steel ball dropping on the back of a panel simulates the effect of a stone thrown up against a fender or underbody. This enabled us to produce parts that would stand such blows not only without serious fracture, but without marring the surface.

Materials intended for use in transformers and other electrical equipment are tested for dielectric strength, arc resistance, dielectric constant, and dissipation factor. A new 3,000-psi. press can be used for compression testing, for a special shear test, and for other experimental work. An electric oven, accurate to 100-500° F. $\pm$ 2° is used both in the experimental program on post-curing and in crazing tests. The latter are important to the MFG Boat Co., since many resins tend to craze at the step in a lapstrake hull.

One of the objectives of the testing program was to develop a file of information and thus facilitate the selection of materials for specific product performance. The size of this undertaking can be judged from a recently completed test series on reinforcement materials (primarily random mat and preform). In the Physical Lab, 20 panels were tested before exposure and 20 more after exposure. Fifteen values were taken on each panel, and each value involved five tests—a total of 3,000 tests for this series alone.

Both hardness and depth of coating are tested on all panels with an ultra-sonic abrasion drill which operates at 20,000 cycles per second at intervals ranging from 15 to 120 seconds. To relate abrasion tests directly to actual product service conditions, RECO is developing its own mechanical abrasion tester. This machine has mechanical feet which can be fitted with any chosen abrasive material and which will move back and forth over the fixed sample, applying abrasive with controlled speed and pressure.

Endurance lab

A development program with potential importance to the industry is the bonding material project. A special section has been set up to test both production workability and final physical properties. The project was instituted for continuous-assembly improvement of Corvette bodies and White truck cabs, but will be equally valuable for any product involving assembly of many reinforced plastic parts. The ideal bonding material should stick readily on application, yet be pliable and workable. It must not flow at room temperature. These qualities are the first tested.

Fig. 1. Chemical lab. Note reactor in background.

To determine strength of bond, RECO runs a shear test and has devised a new test which yields even more significant data. Two 1 x 3-inch pieces are bonded as a cross, then put in a fixture which grasps the four un-bonded ends and pulls the pieces directly apart with calibrated force.

Finally, bonded assemblies are tested for hair-line cracks, using a standard flexural test. Actually, the hair-line crack has no effect on the strength and durability of the bond but, since it may worry the customer, we have worked to eliminate it. Also in the flexural test, load is increased and deflection recorded until the sample breaks.

Exposure lab

The Exposure Lab not only provides direct information on the effects of weathering, chemicals, and other forms of exposure but permits the Physical Testing Lab

Fig. 2. Electric oven used both for post-curing and crazing tests.

Fig. 3. Physical lab. Flexural testing at left, impact at right.

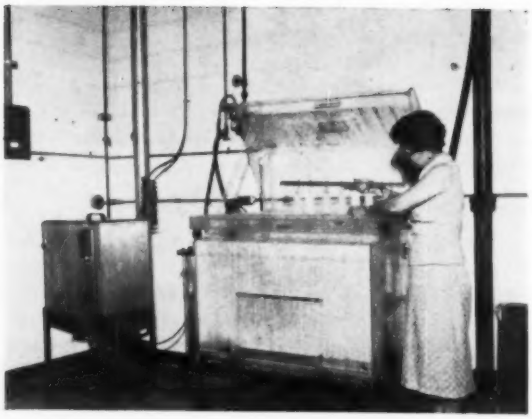


Fig. 4. Humidity cabinet in the Exposure lab.

to determine the effect of such exposure on the full range of physical properties. Standard tests include: a constant boil bath in which samples are exposed for 24 hours at the boiling point of water; a humidity cabinet where samples are kept for 500 hours at 100° F, and at 100% relative humidity; a super fadeometer which subjects samples to ultraviolet light for 4, 6, and 8 hours; a weatherometer for 1,000-hour weathering tests; and roof racks for outdoor exposure.

A sodium carbonate bath keeps samples at 180° F., for a minimum of 44 hours and up to 88 hours to test resin leach-out. Another accelerated test is the exposure of samples at 160° F. for 4 days in gasoline, distilled water, a 10% NaOH solution, a 3% solution of nitric acid, and a 10% hydrochloric acid solution. Other acids are included if the end product is intended for such exposure. Samples are also exposed to a wide variety of chemicals at room temperature for 30, 60, and 90 days.

The practical value of such testing is obvious. A great many products must withstand weathering—automobile bodies, boats, street light housings, to name a few. Since resistance to corrosion is a major feature of reinforced plastics, they are used for many products exposed to chemical and corrosive fumes. Recently, we introduced a 200-gallon tank for storing agricultural chemical sprays. Whenever a specification calls for resistance to a chemical not previously tested, the Exposure Lab is assigned the project.

RECO's elaborate test program necessitates an equally complicated system of cross-indexed records. The labs maintain progress charts and know at any moment the status of every sample under test. The final report on each set of samples includes not only the physical test data before and after exposure, but as many as 16 actual samples for visual inspection of the effects of various exposure tests.

Though the research center is relatively new, MFG reports that it has definitely demonstrated its value both in quality control and in materials and product development. It is our intention to share much of the test data obtained with all of the reinforced plastics industry in the interest of up grading all our products.

—THE END

Plastics may take over car interior

Among the exhibits at the National Plastics Exposition this June will be an entire car interior molded of Cycolac acrylonitrile-butadiene-styrene material.

The steering wheel, according to Marbon Chemical Division, Borg-Warner Corp., demonstrates the toughness, rigidity, and pleasant feel of the resin. The vacuum-metallized panels of ABS which make up the instrument cluster replace die cast, chrome plated metal parts. High impact resistance and good electrical properties suit Cycolac for the one-piece transmission console. Overhead, the one-piece ceiling provides ¾-in. more head room than fabric liners. Quickly produced, it is snapped into place. The cantilevered seat shells are vacuum formed in one piece, as is the trunk liner.

Molded into the inside door liner are arm rests, ashtrays, and decorations. The vacuum-metallized material in the tail light, head lamp, and dome reflector bezels indicate the material's resistance to heat distortion.

Cutaway view of Cycolac car interior.

Determining stabilizer efficiency— oxygen bomb vs. oven heating vs. milling

While all three methods are suitable for high-temperature testing, the oven method is particularly suited for adaption to low temperature aging tests. Remember, these methods are all accelerated testing, and should not be substituted for long-term testing under ambient atmospheres. Although set up for polyethylene, the same methods could be adapted to studying stabilization of vinyl.—Editor.

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MRS. A. L. PERUN**

There is no question of the importance of stabilizing polyethylene against oxidation. What, then, are quick, yet valid and efficient test methods for finding effective antioxidants? One greatly used method is the Norma-Hoffman Oxygen Bomb test, which measures polyethylene oxidation induction time by the drop in oxygen pressure during aging at 140° C. This bomb method, however, seems cumbersome and somewhat time consuming and many (1, 2)*** have suggested that the method is theoretically unsound—objections which seem valid. Nevertheless, as will be seen later, the bomb test correlates quite well with other methods of determining stabilizer efficiency at processing temperatures.

As early as 1946, Le Bras (1) found that some antioxidants reduce the oxygen consumption rate to ⅓ or ¼ the original rate. Others, although protecting rubber, do not reduce the rate at all but rather operate by decomposing the peroxide. Thus, a test method which depends on the measurement of oxygen consumption rate may give false results.

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According to Kennerly (2) and Patterson, a screening test for antioxidants which shortens induction periods by raising the oxygen pressure can give totally misleading results. The ASTM gasoline oxidation stability test, run at 100 psi. of oxygen, will multiply the rate of inhibitor-oxygen reaction by a factor of 35 over a test at the same temperature run with air at atmospheric pressure. However, the rate of inhibitor-peroxide interactions should not be affected by pressure. Thus, the test does measure the susceptibility of an inhibitor to attack by oxygen and not its ability to protect a system from oxidation.

What method can be used to test for oxidation stability of polyolefins? The only completely reliable test is one that measures what is happening to the resin. Both power factor or carbonyl content and some physical property such as melt index, tensile strength, or elongation should be measured. These measurements would cover both electrical and physical properties. The resin could be degraded by milling or oven heating. The work that follows discusses the efficiency of some of these methods compared to the oxygen bomb.

Test conditions

Milling procedure

A master batch technique was used to provide a

thorough dispersion. The antioxidant at 0.05% concentration was milled into the resin on a two roll mill at 110° C. The resin was then fluxed before the stabilizer was added. In the next step, the resin compound was given 10 end passes and sheeted off. Part of this batch was then milled as above with virgin Bakelite DYNK polyethylene to give 300 grams at a final concentration of 0.01%. The 0.05% compound was used for the oxygen bomb test while the 0.01% material was used for the 170° C. milling, and the 110° C. and 170° C. oven procedures.

Norma-Hoffman bomb test#

About five grams containing 0.05% antioxidant were ground to 20 mesh in a Wiley Mill. A 200-milligram sample was distributed between layers of glass wool in the sample holder, and two grams of calcium oxide (to absorb the products of combustion) were added. The sample holder was placed in the bomb cavity and the top secured. Then, the assembled bomb was charged with oxygen (50 psig is sufficient), placed in water, and checked for leaks which destroy the test's validity. Finally, the bomb was placed in the constant temperature bath at 140° C., and the change in oxygen pressure with time was automatically charted with a Foxboro Recorder.

The induction time of oxidation is determined in this manner. Pressure is plotted on the ordinate and time on the abscissa. The pressure will remain fairly constant prior to the end of the induction time but, after the induction point has been reached, there is a sharp pressure drop which will eventually reach a minimum after the resin has completely oxidized. Therefore, the intersection of a straight line drawn through the points after the induction point has obviously been passed, but before the pressure begins leveling off, is the induction point of oxidation (see Fig. 1a).

Oven aging at 110° and 170° C.

About 30 grams of resin containing 0.01% antioxidant were pressed in a 6- by 0.030-inch single cavity mold with a hydraulic press. The pressed sheet was cut into approximately 2- by 3-inch rectangles and stapled securely between two sample size pieces of lightweight card stock in which 1- by ½-inch windows had been cut. These sample holders are easily suspended in the oven and in the infrared spectrophotometer. A separate sample was used for each period of aging time; weight per cent carbonyl was analyzed via infrared.

Milling test procedure at 170° C.

Two hundred and sixty grams of resin were milled on a two roll mill held at 170° C. The distance between rolls and the height of the rolling bank was kept constant. Forty gram samples were removed at half-hour intervals and the milling was continued until the resin, which up till now had been on only one roll (the hottest), suddenly flopped over onto the second roll. This abrupt transition of the resin during milling from one or two rolls is known as the time to sticking or the sticking point. Various analytical and physical tests were run on the samples which had been removed periodically.

ASTM Test Method D-942-50.

Measurement of carbonyl by infrared

Measurements were made at 5.84μ in the following manner:

$$\text{Absorbance} = \log \frac{I_o}{I} = A$$

$$\text{Carbonyl wt. } \% = \frac{A}{t} \times 4.56$$

where

I_o = Incident radiation, transmission per cent
I = Transmitted radiation, per cent
t = Thickness in mils
4.56 = Factor

Suitable conditions for this particular work with a Perkin-Elmer Model 21, double beam monochromator are a slit program 984 (2 resolution), gain 5.5, speed three, and a gear ratio which permits two inches per miron.

Physical tests

Tensile strength and per cent elongation

These tests were run according to ASTM D638-52T. Tensile strength has a precision of ±5% and percent elongation ±10% (based on the 95% confidence limit).

Melt index

The melt index signifies the time it takes 10 grams of resin to flow through an orifice at 190° C. and 44 psi. It was run per ASTM D1238-57T at a precision of ±7%.

Discussion of test methods

Norma-Hoffman oxygen bomb

In the bomb, the resin is exposed to oxygen under pressure and is at a 140° C. bath temperature. The test measures the oxidation induction time, or the time at which the oxygen pressure starts to drop. Veprek (3) has demonstrated that antioxidants (such as DBPC)† which have short induction times in the bomb do not protect polyethylene in electrical applications. On the other hand, "Santonox" R†† antioxidant gives a long bomb-induction period and also adequately protects electrical properties.

Fig. 1 presents typical oxygen bomb curves showing the induction time and the rate of change in oxygen pressure. The induction time represents the time required for the pressure to drop in the sample containing antioxidant minus the time required for the pressure drop in the resin containing no antioxidant. The oxygen bomb test sometimes shows poor reproducibility, possibly due to faulty apparatus, operator variables, or poor antioxidant dispersion. Induction times of replicate runs of a few samples are presented in Table 1.

†Di-(2,6-t-butyl)-4-methyl phenol
††4,4'-Thio bis (6-t-butyl-m-cresol)
†††N,N'-di-sec-butyl-p-phenylenediamine

Table 1. Reproducibility of Norma-Hoffman Bomb Oxidation Induction Period

Antioxidant	Induction Time, Hours
"Tenamene" †††	5.3, 13.5
p-Amino phenol	7.3, 15.3
Lauryl gallate	5.3, 9.3, 11.1, 10.1, 7.1

In addition to poor reproducibility, there is doubt about validity of the end point taken. With some compounds, there seem to be two end points (two locations on the curve at which the pressure drops). An example of two possible end points is seen in the oxygen pressure vs. time curve in Fig. 1b.

Which is the true end point? Is there more than one end point? It is well known that antioxidants may react with molecular oxygen, and perhaps the first pressure drop is such a reaction. However, the complexity of the oxidation mechanism in the presence of inhibitors precludes even an educated guess at the moment.

Two other variables are noted on further examination of the curves. Occasionally, there is a rise in pressure before the first or customary induction time. Also, the rate of drop in oxygen pressure after the induction time varies. These variables are found between antioxidants as well as in replicate runs of the same antioxidants.

A pertinent question here is: Are the aforementioned variables due to antioxidant structure or to poor test method performance? Unforunately, no accurate answer can be drawn from the present state of knowledge.

In view of the foregoing discussion it can be seen that the Norma-Hoffman oxygen bomb test may not be a good routine analytical tool.

Milling stability at 170° C.

The most desirable test method is one that simulates processing or use conditions. A method similar to the 170° C. milling procedure is already in use as an ASTM standard test (D1248-58). In adapting this test to our needs, two criteria were used to determine stabilizer efficiency. One was rate of carbonyl formation; the other the period of milling time until the resin stuck.

Fig. 2 presents typical curves depicting the rate of carbonyl formation of poor (DBPC) and good ("Santonox" R) antioxidants. Each curve has three portions: a time period during which no carbonyl forms, a short period of rapidly increasing rate and, finally, the constant rate portion. The end point used as a basis for comparing rates of carbonyl formation could be the time to formation of 0.1% carbonyl. An alternate and probably preferable end point (see dotted lines in Fig. 2) is the period of time found by extrapolating the constant rate portion of the curve back to the X, or time, axis.

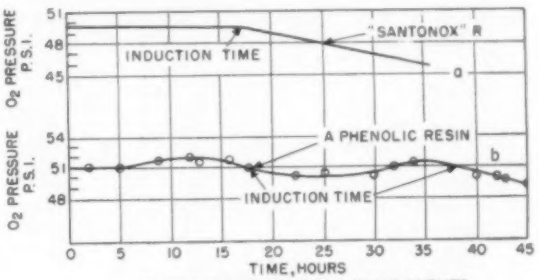
The second, and much simpler, criterion used to determine stabilizer efficiency was the period of milling time until the resin stuck to both rolls. At this point the resin properties have considerably changed from the normal, as revealed by the change in melt index with milling time (Fig. 3). Table 2 demonstrates the excellent reproducibility of replicate runs using the sticking point as the end point.

The greatest single variable in the sticking point technique is the dependence of the "time to sticking" on the melt index of the resin. Table 3 gives the time to stick-

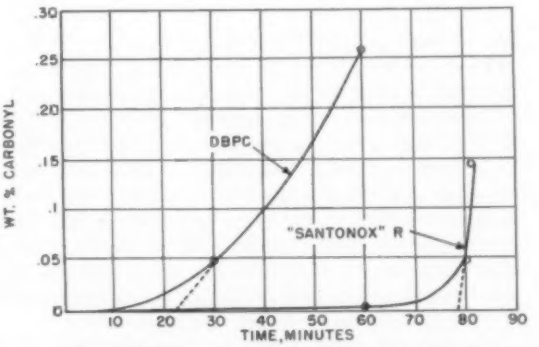
Table 2. Reproducibility of Sticking Point as the End Point During 170° C. Milling

Antioxidant	Time to Sticking, Minutes
"Santonox" R[1]	82, 80, 83
CKR 0036[2]	48, 50

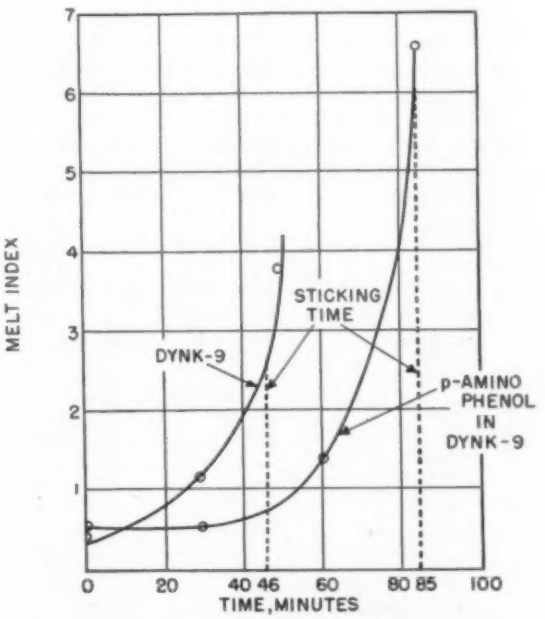
1) 4,4'-Thio bis (6-t-butyl m-cresol)
2) p-tert-Amyl phenol formaldehyde resin



TYPICAL NORMA-HOFFMAN BOMB CURVES
OXYGEN PRESSURE VS. TIME
FIGURE 1



RATE OF CARBONYL DEVELOPMENT DURING 170 DEG. C. MILLING
FIGURE 2



MELT INDEX IS MILLING TIME AT 170 DEG. C.
FIGURE 3

Table 3. Dependence of Time to Sticking on the Melt Index of the Resin

Melt Index of Bakelite Polyethylene Resin DYNK Used	Time to Sticking, Minutes
0.35	49, 50
0.26	64, 66

Table 4. Ranking of Antioxidant Efficiency Using the Two End Points of the 170° C. Milling Procedure

Antioxidant	Time to 0.1% C=O, Minutes	Time to Sticking, Minutes
Hydroquinone	33	37
2-Ethyl hexyl octyl phenyl phosphite	38	41
o-Amino phenol	40	41
CKR 0036[1]	42	50
"Tenamene"[2]	42	60
Lauryl gallate	47	60
"Santonox" R[3]	82	83
JZF[4]	90	90

1) p-tert-Amyl phenol formaldehyde resin
2) N,N'-di-sec-butyl p-phenylenediamine
3) 4,4' Thio bis (6-t-butyl m-cresol)
4) N,N'-di-phenyl p-phenylenendiamine

ing of two lots of DYNK resin of melt index 0.26 and 0.35 respectively. Each lot is reproducible within itself, but there is a significant difference between the two lots.

Other variables which must remain constant in the 170° C. milling test are the roll temperature, amount of resin used, and the bank weight. The latter is weight of the resin in the rolling bank in the nip between the two rolls. It depends primarily on two factors: melt index of the resin, and distance between the rolls. Since the melt index will vary with every batch, controls must be run with each new batch of polyethylene. In addition, the roll openings must be kept constant.

As shown in Table 4, both methods (time to sticking and rate of carbonyl formation) rank the antioxidants in the same order of efficiency.

Although the rate of carbonyl formation or sticking point indicate the effect of oxidation on the resin, each must also be correlated with changes in physical properties to obtain an accurate picture. Accordingly, several stabilized compounds were analyzed during 170° C. milling for changes in tensile strength, per cent elongation, and melt index. Table 5 lists these data for four representative samples which were milled to the sticking point.

Table 5 reveals that, as milling proceeds to the sticking point, tensile strength and per cent elongation decrease significantly. At the sticking point, the melt index has also increased at least tenfold from the original value. Fig. 3 (the plot of melt index vs. milling time) shows a rapid rise near the vicinity of the sticking point. Thus, the sticking point can be explained in terms of the significant changes in physical properties which have taken place in the resin during milling.

Oven aging at 170° C.

Although the 170° C. milling test is a good replacement for the Norma-Hoffman Bomb, it is still somewhat time consuming. To provide a simple alternate method, rate of carboyl formation was followed by oven aging at 170° C. The curves plotted in Fig. 4 are of the same general shape as those found for rate of carbonyl formation during milling at 170° C. Two end points can be used to determine the length of the induction period. One is the time required for the development of 0.03 weight per cent carbonyl. The second is the time found by extrapolation of the constant rate portion of the curve back to the X, or time, axis.

There are three very significant variables. The two most important ones occur when the oven is opened periodically to remove samples. The time it takes for the oven to return to 170° C. will vary with the oven. It will also vary with the length of time the oven door was open, which in turn depends on the number of samples being tested and the efficiency of the operator. Another probable variable will be the location of the samples in the oven, i.e., their distance from the heating elements. Of all the methods discussed, oven aging at 170° C. provides adequate data with the least amount of time.

Oven aging at 110° C.

The tests so far discussed were chosen to simulate high temperature processing conditions. We believe that there should also be a test method more nearly akin to actual low temperature use conditions. Aging at 60° C. would be ideal; however, stabilized resin would degrade much too slowly at this temperature. As a reasonable compromise, oven aging was carried out at 110° C.

Typical curves for rate of carbonyl development at 110° C. are shown in Fig. 5. They are identical in general shape to similar curves found in 170° C. milling

Table 5. Changes in Physical Properties During 170° C. Milling

Antioxidant	Milling Time, Minutes	Melt Index	Weight % Carbonyl	Tensile Strength Psi	Tensile Strength % Retained	Elongation %	Elongation % Retained
Lauryl gallate	0	.32	.003	2350	—	650	—
	30	—	.026	2040	—	545	—
	60	3.8	.155	1810	77	595	91.5
CKR 0036[1]	0	.34	.003	2300	—	655	—
	30	—	.048	2030	—	600	—
	60	11.0	.141	1710	74	590	90
Hydroquinone	0	.33	.003	2480	—	645	—
	30	—	.073	1910	—	525	—
	37	4.8	.131	1440	58	540	83
o-Amino phenol	0	.31	.003	2400	—	585	—
	30	—	.055	1870	—	545	—
	41	2.8	.107	1730	72	455	78

1) p-tert-Amyl phenol formaldehyde resin

Table 6. Correlation Between Test Methods

	Norma-Hoffman Oxygen Bomb		170° C. Milling		170° C. Oven		170° C. Oven	
	Hours	Rating	Minutes	Rating	Minutes	Rating	Days	Rating
DYNK	0	P	0	P	15	P	1	P
4-tert-Amyl 2, 6-bis (2-hydroxy 5-tert-amyl benzyl) phenol	0	P	11	P	39	P	6	G
"Pepton" 65[1]	0	P	15	P	36	P	2	F
DBPC[2]	1.1	P	25	P	15-30	P	1	P
Triphenylmethane	1.8	P	—	—	—	—	1	P
Hydroquinone	1.9	P	23	P	30	P	1	P
o-Amino phenol	3.2	P	29	P	40	P	2½	F
"Tenamene"[3]	6.3	F	42	F	49	F	1½	P
Lauryl gallate	8.6	F	46	F	—	—	12	VG
CKR 0036[4]	10.5	G	39	F	80	G	12	E
p-Amino phenol	10.7	G	39	F	60	F-G	1½	P
"Aranox"[5]	15.8	G	28	P	65	F-G	—	—
"Santonox" R[6]	18.3	VG	53	G	73	G	12	VG
JZF[7]	39.4	E	90	E	120	E	5½	G

1. A Cyanamid product
2. di-tert-Butyl p-cresol
3. N,N'-di-sec-butyl p-phenylenediamine
4. p-tert-Amyl phenol formaldehyde resin
5. p-(p-Tolyl sulfonylamido diphenylamine
6. 4,4'-Thio bis (6-t-butyl m-cresol)
7. N,N'-di-phenyl-p-phenylenediamine

and oven aging. The two methods of determining induction time are the same as previously described for 170° C. oven aging. Reproducibility is excellent.

Correlation of test methods

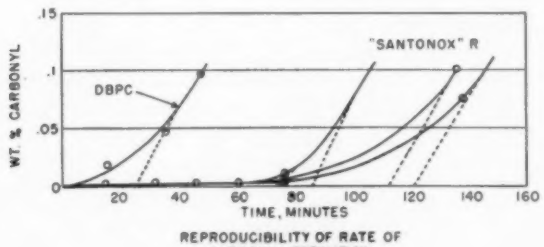
How do these various methods correlate with each other? Table 6 lists all the data collected using the four methods previously discussed. In the bomb and 170° C. milling methods, the induction time for the unstabilized resin is subtracted from each value. For the oven methods, the results are set down as obtained, i.e., induction time for the unstabilized resin, DYNK, is not zero. Every stabilizer tested is given a ranking of poor (p), fair (f), good (g), very good (vg), and excellent (e), within each method. By this "visual" ranking, a poor correlation is one where the ratings by two different methods are at least two apart, i.e., one rating is fair while the other is very good. A fair correlation is one where the ratings are in adjoining categories.

Consider first the bomb vs. 170° C. milling. Fig. 6 is a plot of bomb induction time vs. induction times by 170° C. milling. There are a few deviations; "Aranox" antioxidant being a major one. But, in general, the correlation is good. Both methods (Table 6) rank the antioxidants in the same general category. Exactly the same conclusion applies to the correlation of the bomb vs. the 170° C. oven (see Fig. 7 and Table 6).

The correlation between the 110° C. oven and the other three methods is only fair (Fig. 8, Table 6). Although the majority of antioxidants are ranked in the same general category by 110° C. as by the other three higher temperature tests, there are a number of exceptions. This probably means that some antioxidants do not behave the same way at high as at low temperatures. The correlation may be even worse than shown if the low temperature aging were carried out at more realistic temperatures, such as 60° C., or even ambient.

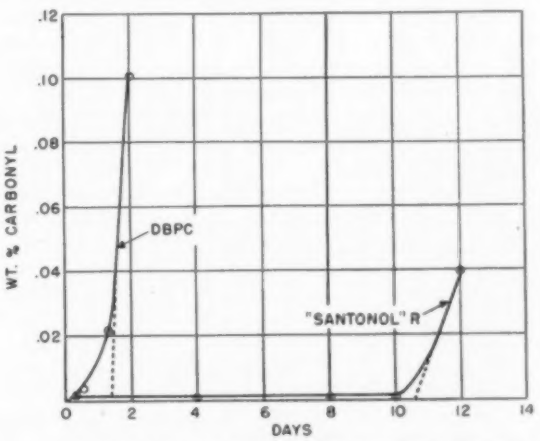
Theoretical basis for rate of carbonyl formation curves in the milling and oven tests

A close examination of the rate of carbonyl formation curves for the milling and oven tests will reveal that the curves have three sections. First, there is a time period where no carbonyl forms, second a stage of rapidly in-



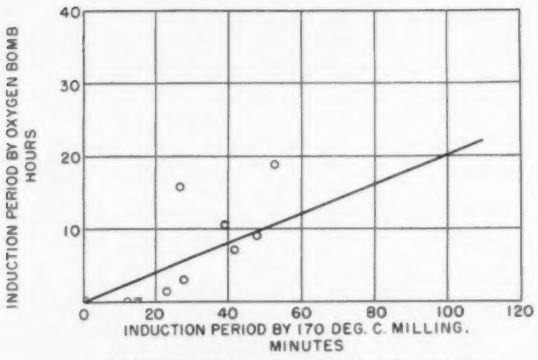
REPRODUCIBILITY OF RATE OF CARBONYL FORMATION DURING OVEN AGING AT 170 DEG. C.

FIGURE 4



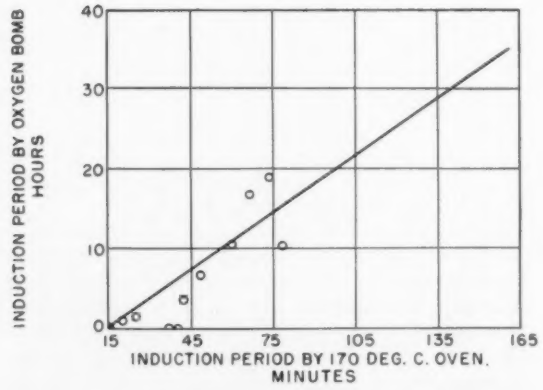
RATE OF CARBONYL FORMATION DURING OVEN HEATING AT 110 DEG. C.

FIGURE 5



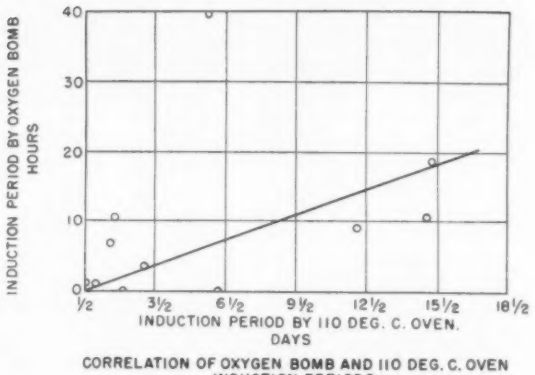
CORRELATION OF OXYGEN BOMB AND 170 DEG. C. MILLING INDUCTION PERIODS

FIGURE 6



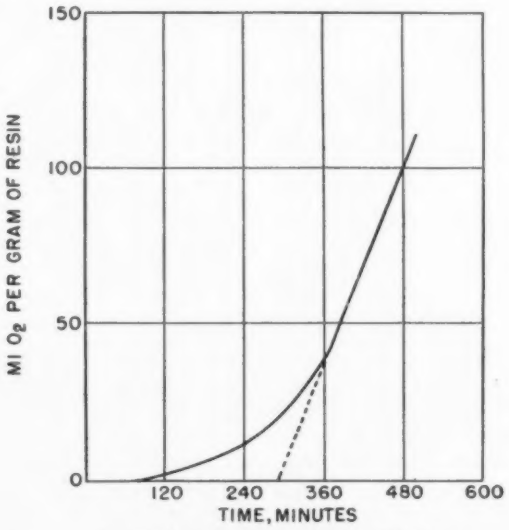
CORRELATION OF OXYGEN BOMB AND 170 DEG. C. OVEN INDUCTION PERIODS

FIGURE 7



CORRELATION OF OXYGEN BOMB AND 110 DEG. C. OVEN INDUCTION PERIODS

FIGURE 8



TYPICAL OXYGEN UPTAKE CURVE FOR "BAKELITE" POLYETHYLENE RESIN DYNH, 140 DEG. C.

FIGURE 9

creasing rate, and finally a constant rate portion of the curve. The close analogy between these curves and the oxygen uptake curve of Biggs (4) and Wilson (5) (see Fig. 9) is very apparent. The latter two determined the oxygen susceptibility of polyethylene by measuring volume pickup at constant temperature and pressure according to the method of Shelton (6). The portion of their curve which has a rapidly increasing rate represents the autocatalytic stage of the oxidation. The extrapolation of the constant rate portion of their curve back to the X axis gives the oxidation induction period. The rate of carbonyl formation curves indicate the same autocatalytic mechanism.

In order to account for the autocatalytic nature of the early stages of ethyl linoleate oxidation, Bolland (7) postulated a free radical mechanism. This mechanism, which follows, has been found to apply to both low (8) and high (4, 5) molecular weight hydrocarbons (polyethylenes).

Initiation	1.	Formation of R·
Propagation	2.	$R\cdot + O_2 \longrightarrow RO_2\cdot$
	3.	$RO_2 + RH \longrightarrow RO_2H + R\cdot$
Termination	4.	$R\cdot + R\cdot \longrightarrow R\text{-}R$
	5.	$R\cdot + RO_2\cdot \longrightarrow RO_2R$
	6.	$2RO_2\cdot \longrightarrow RO_2R + O_2$

The first reaction, Initiation, could occur by the breakdown of the hydroperoxide, RO_2H. This hydroperoxide can form either by direct air oxidation of an activated weak spot in the resin (9) or through Propagation, reaction "3". The latter effect, however, assumes more importance (8) as autoxidation proceeds. The nature of the curves (rate of carbonyl formation) in the milling and oven tests reveals that this same general mechanism applies even in the presence of antioxidants.

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—THE END

Casting polypropylene film

Major processing variables in the chill-roll casting of polypropylene film are presented along with their effects on film properties and production rates. Cautions to observe include: Don't exceed level of extruder capacity; Keep draw distance as short as possible; Operate at highest permissible stock temperatures for optimum clarity; Chill film quickly; and Keep gap setting as high as possible without sacrificing gage control.—Editor.

R. L. WIBBENS*

Polypropylene was first introduced domestically by Hercules Powder Co. only three years ago. In that short time, the plastics industry has become more and more aware of its usefulness in a variety of forms—especially, as film. Like any material, polypropylene's use in film will be determined by its physical characteristics as balanced against economics, when compared with other available film resins.

Polypropylene films can be produced by a number of methods, of which chill roll casting is the most widely used. The processing techniques employed will have a marked effect on both film quality and cost. Extensive laboratory and field evaluations by Hercules indicate that at least five major processing variables affect film properties and production rates.

Information presented in this article is based on a series of lab studies of these processing variables. The studies were intended to outline procedures for the economical manufacture of quality polypropylene film on commercial equipment. No attempt is made to compare properties or costs with competitive film materials. This type of information is readily available from resin suppliers.

Equipment involved

Since top quality polypropylene film can be produced economically on standard commercial equipment (See Fig. 1), such facilities were used throughout the studies and no special machinery was investigated. The machine used was a 2.5-inch extruder with a 20:1 L/D ratio. This longer barreled extruder permits a longer dwell time; therefore, production rates comparable to polyethylene can be obtained. A 4:1 compression-ratio, polyethylene-type metering screw was used throughout, although other screws such as the polyethylene-type with a tapered approach to the metering zone and a fully-tapered, root-diameter screw would operate equally well.

A "coat-hanger" type die was chosen instead of the "straight-Tee" bore to control pressure distribution across the die width and minimize surge. The chill roll casting unit has two 8-inch (diameter) rolls, double-walled to encompass an annular space for high-velocity water cooling. Spiral baffles minimized temperature differentials on the mirror finish, chrome plated roll surfaces. A water chilling refrigeration unit was employed to maintain the controlled temperatures required for proper casting conditions. Pro-fax** polypropylene resin (Type 6420) was the material used.

Processing variables

A controlled series of experiments was conducted to determine the effect of the five major processing variables on film properties. Each variable was studied independently as outlined below. Interactions of the variables were not examined specifically, but in the course of the work, definite inter-relationships between certain variables became evident.

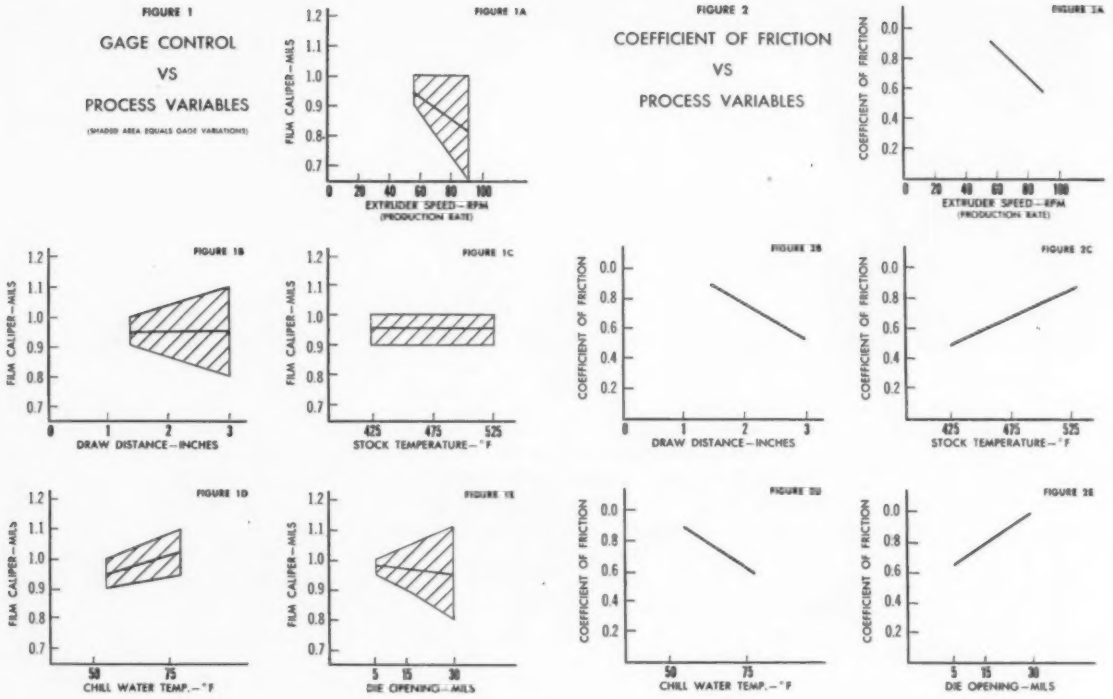
PRODUCTION RATE. The rate was varied from 55% to 90% of extruder capacity. As the extruder speed was increased, film windup speeds were also increased to maintain a film of approximately 1 mil gage.

STOCK TEMPERATURE. As measured by an immersion type thermocouple in the die throat, this temperature was varied from 475 to 575° F.

CHILL ROLL WATER TEMPERATURE. The water tem-

* Plastics Sales Dev. Rep., Hercules Powder Co., Wilmington, Del.

** Registered trademark of Hercules Powder Co.



perature in the chill roll was varied from 54 to 78° F.

DRAW DISTANCE. This distance, in terms of free film travel from the point of leaving the die lips to the point of contact on the chill roll was varied from 1.4 to 3 inches.

DIE OPENING. The die opening was varied from 5 to 30 mils. Resulting films were then examined for the following properties: gage variation, coefficient of friction, clarity or haze level, tensile strength#, tensile elongation#, tensile modulus##, extrusion quality, and impact strength as measured by the Dart Method.

Effects of processing variables on film properties

GAGE CONTROL (CALIPER SURGE). Figures 1A through 1E depict the effects of the process variables studied on gage variation. Production rate (Fig. 1A), as measured by extruder capacity, appears to be an important variable in controlling film gage. When approximately 75% of extruder capacity was exceeded, caliper variation was excessive. Two other variables which seriously affected gage control were draw distance (Fig. 1B) and die opening (Fig. 1E). As each of these variables were increased, an increase in gage variation was obtained.

COEFFICIENT OF FRICTION. Figures 2A through 2E show the effect of process variables on film slip. An increase in production rate (Fig. 2A), draw distance (Fig. 2B), or chill roll water temperature (Fig. 2D) lowers the coefficient of friction. A stock temperature increase (Fig. 2C) or an increased die opening (Fig. 2E) raises the coefficient of friction.

CLARITY. Increases in production rate (Fig. 3A), draw distance (Fig. 3B), and chill roll water temperature (Fig. 3D) decrease clarity; while increased stock temperature (Fig. 3C) and die openings (Fig. 3E) improve the clarity of cast films. A comparison of Figures 2 (A-E) and 3 (A-E) shows the inverse relation between the properties of slip and optical clarity.

TENSILE PROPERTIES. Production rate has a pronounced effect on the film's tensile strength and elongation. Figures 4A and 5A show the adverse effects of exceeding approximately 75% of extruder capacity. Tensile modulus is increased by an increase in production capacity (Fig. 6A), and also by an increase in chill roll water temperature (Fig. 6D). Variables other than these two had little or no effect on tensile properties.

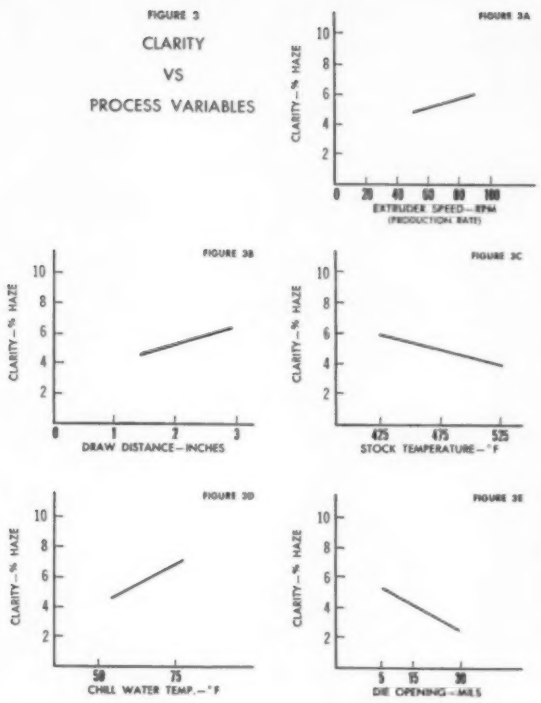
EXTRUSION QUALITY. In Figures 7A through 7D, extrusion quality—as measured by gel count (a physical count of the number of gels per 10 square feet of film)—is unaffected by draw distance (Fig. 7B), stock temperature (Fig. 7C), or chill roll water temperature (Fig. 7D). As might be expected, increased production rates (Fig. 7A) result in decreased extrusion quality.

IMPACT STRENGTH. Fig. 8 summarizes the effect of process variables on the impact strength of films. As production rate (Fig. 8A), draw distance (Fig. 8B), and chill roll water temperature (Fig. 8D) were increased there was a corresponding decrease in impact resistance. Increasing the die opening (Fig. 8E) gave a considerable improvement in impact strength.

Interaction of process variables

Optimum gage control can be maintained at slow production rates, short draw distances, and small die openings. In commercial production, the tendency towards surging brought about by increased speeds can be offset by decreasing either or both the film

ASTM Test Method D-882-56T. Crosshead speed 20 in./min.
ASTM Test Method D-1530-58T. Crosshead speed 0.2 in./min.



Chill roll casting of polypropylene film at Hercules lab.

draw distance or the size of the die opening. If the draw distance is the minimum permitted by the dimensions of the equipment, the die opening must be reduced to improve the production rate.

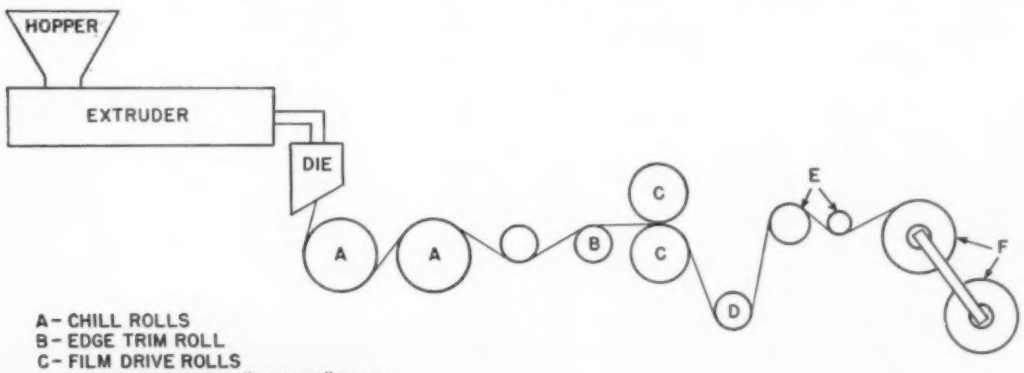
Graphs 2A through 2E, and 3A through 3E indicate that proper balancing of process variables is vital to produce film of optimum clarity and slip. If, for example, chilling water temperatures are limited, stock temperature and production rate must be adjusted tc compensate—thus achieving a balance of clarity and friction properties.

Tensile modulus, a measure of film stiffness and machinability, is related to both chill water temperature and production rate. When coolant temperatures are fixed, processing rate changes will affect tensile modulus directly. Impact strength is affected by all the major processing variables, with the exception of stock temperature. If chill water temperature and/or draw distance are fixed, impact strength can be improved by changing the die opening or the production rate.

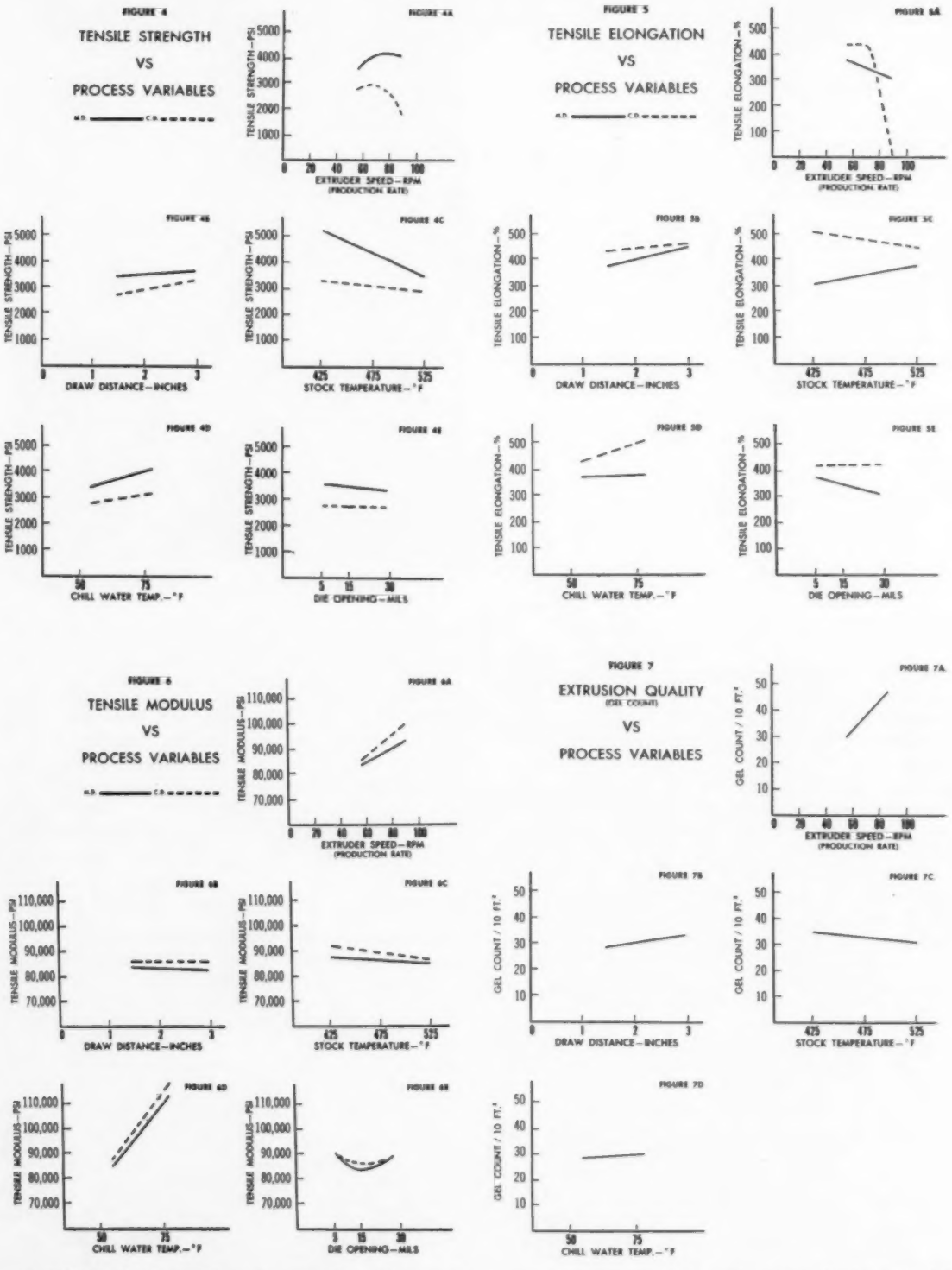
While it is apparent that film properties can be controlled within practical limits with the five major processing variables, they are so inter-related that changes made to improve one property may affect another property adversely. The producer must determine what constitutes a satisfactory balance of properties for his particular film specifications. Processing variables are adjusted accordingly.

Conclusions

Our studies indicated several important guiding principles for producing top quality polypropylene film. First, there is a level of extruder capacity (75% in



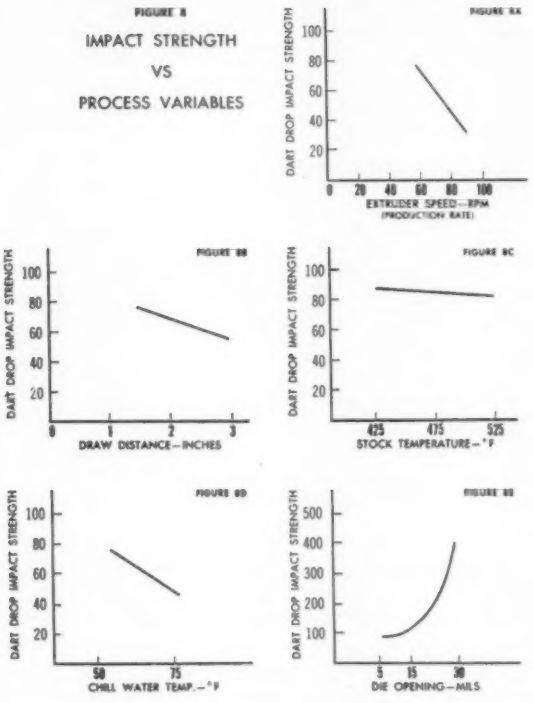
Schematic diagram of set up for casting polypropylene film.



our studies) which should not be exceeded. Above this level we encountered problems in gage control, extrusion quality, and tensile properties. Draw distance should be as short as possible—on the equipment used, never over 1.5 inches. Longer draw distances result in excessive gage variations, decreased clarity, and decreased impact strengths. These drawbacks outweigh the slight improvement in tensile properties obtained with a longer draw. Dimensional limits of the machine prevented our using a draw distance shorter than 1.5 inches. Had this been possible, it would appear that still better gage control, clarity, and impact strength

FIGURE 8

IMPACT STRENGTH
VS
PROCESS VARIABLES



would have been obtained.

Operation at the highest possible stock temperature which still permits the maintenance of a reasonable melt strength will improve clarity. Tensile strength decreases somewhat as stock temperature increases, but this is of lesser importance than optimum clarity. Stock temperatures of at least 525° F. are desirable.

Chilling the film quickly by keeping the water in the casting roll as cold as possible will also improve clarity. Quick chilling improves impact strength, and chill water temperatures of 60° F. and lower are indicated. A die gap setting of 15 mils (set while the die is hot) appears optimum for controlling gage variation. Both impact strength and film clarity are greatly improved by an increased gap setting. When it becomes possible to increase the gap setting without sacrificing gage control, we will obtain a superior polypropylene film. Such an improvement should be possible with a die designed to permit a shorter draw distance, thus overcoming the surge caused by a larger gap.

Great strides have already been made and, as the number of polypropylene film producers increase, refinements in processing techniques will be devised. Quality film is already serving a wide list of markets, and can be expected to assume its rightful place as one of the most useful of modern film products.

—THE END

ENGINEERING FORUM

Reinforced plastics

Heavy profits in heavy laminates

Edited by: HARRY T. DOUGLAS*

It has long been a source of surprise to me that so few molders have entered the highly lucrative and extremely uncrowded field of producing thick, void-free laminates. This lack of interest seems to have resulted in the field being dominated by a very few firms who have been quietly enjoying the obvious benefits of lack of competition.

Most of the spadework and testing have already been accomplished. The product is extremely acceptable to the user, the pricing is favorable, and know-how is obtainable. With all these factors in one's favor, investigation into the ways and means of participating is certainly in order.

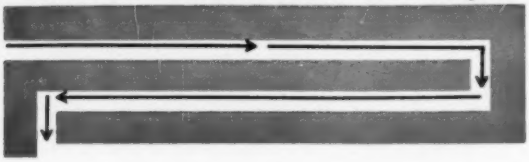
Admittedly, there are problems in manufacturing products using the techniques now in order. Handling forty or fifty plies of glass cloth; learning to impregnate properly; pattern, bag, squeegee, and remove entrapped air; even the proper placement of bleeder and vacuum ports can be tricky. If poorly done, it can become very expensive. In addition, the product must be uniform. It must be within tolerances and must comply with Government specifications since, in most cases, it is the Armed Services who are most interested in the heavy laminates.

Vexing problems, however, can be solved and in a reasonably inexpensive fashion. True, there is a dearth of information—particularly on the important level of foreman and production worker. With experience, though, know-how is quickly developed. Under proper direction, even unskilled crews can produce remarkably uniform laminates in short order. What is equally important, the laminates will be profitable.

For the molder with even modest capital to invest in such a project, the field of heavy laminates is a natural. All he needs is sufficient elbow room and materials handling equipment to cope with the large molds and parts involved.

—THE END

PLASTICS TECHNOLOGY
EXPLORING FABRICATION TECHNIQUES



By L. J. ZUKOR, *ENGINEERING EDITOR*

Automating expanded polystyrene molding

Everyone involved is very concerned about the future of styrene. Industry spokesmen cautiously predict a 5% annual growth over the next few years; however, if this is to come about, both resin manufacturers and processors must embark on extended research and development programs. New resin combinations supported by new and improved processing techniques have broadened polystyrene's markets. Three continuing growth areas* include biaxially oriented film and sheet (see our Jan. issue, page 60); polyesters; and expanded polystyrene for thermal insulation, packaging, and flotation gear.

In the latter case, a process has been accelerated to an automated state in less than two years—after existing with manual processing methods for almost a decade. Automation of molding expanded polystyrene beads (E.P.B.) became an actuality when the mold filling operation was included as an integral part of the molding cycle. Mold filling with E.P.B. presented designers with some very unique problems due, mainly, to the material's low density and frangibility.

Molding E.P.B. material is a two-stage process. The first stage being one in which the processor must transform raw charged granules to expanded hollow beads of a predetermined density. This density can be as low as ¾ lb. per cubic foot. In practice, however, E.P.B. density is usually limited between 2-6 lbs. per cubic foot. It is obvious from the preceding statement that the individual beads are very light and compressible, factors which account for the major design problems of transporting and feeding the material into hot closed molds. After discussing the E.P.B. feeding problem with Frank Lambert,** and making several trials, I found that the beads could not be forced through a tube with any certainty or at anything approaching reasonable velocities (10-20 ft. per sec.) by a pressure from the rear. The material, instead of moving, binds on the tubing side walls and is crushed by the force. This binding, also called bridging, is caused by slight moisture and/or a static charge on the surface of the beads. It therefore becomes necessary to use a combination of push and pull in the design of any filling device.

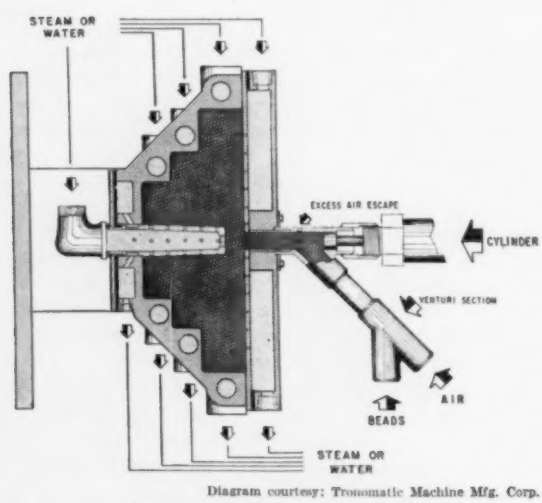
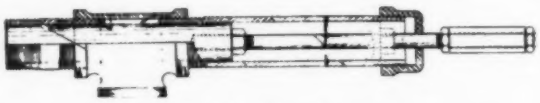
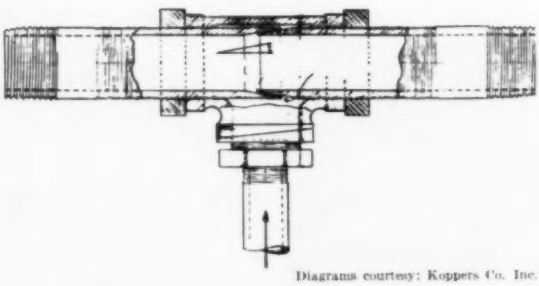


Diagram courtesy: Tronomatic Machine Mfg. Corp.

Christmas tree base—E.P.B. molding.



Mold filler valve.



Diagrams courtesy: Koppers Co. Inc.

Venturi blow filler.

Many designers, in searching for such a mechanism, saw the possibility of using a venturi-type educator which has been successfully adapted for hopper feeding in extrusion and injection molding. Few, however, were able to modify the venturi to work successfully with E.P.B. One of the first working units to be used was a design by Koppers. This unit, although not entirely fool-proof, gave impetus to others who added further refinements. Air relief exhaust ports were added to remove the greater part of the air rushing into the closed mold. Still another refinement was the water-cooled jacket which reduced heat transfer back to the venturi. A build up of heat at the throat could cause bridging to take place.

A cooling jacket allows the venturi-gun to become an integral fixture of a mold. With these features established, a valve was added to close off the inlet port and create a flush plug at the mold. To all of these refinements, Vince Carter, chief engineer in collaboration

* These growth areas refer only to those in the plastics industry. Other growth areas for styrene monomer and polystyrene exist in the fields of rubber, adhesives, and protective coatings.

** Plastic Molding Consultant to Miller & Van Winkle Co., Paterson, N. J.

with Frank Lambert added yet another. The Miller & Van Winkle valve has its feed port situated so that it makes an acute angle with the valve port. Such an arrangement reduces the probability of bridging and causes a smoother flow of beads into the mold. An abrupt change of direction by beads travelling at high velocity can damage them as they impinge on the opposite wall. The use of an air cylinder controlled by a solenoid valve allows the feed-valve to be timed into proper sequence in the machine cycle.

Initial moldings of this material were simple shapes, with at least one flat surface through which the mold could be filled by gravity from a container or a chute equipped with a cut-off valve. Excess is wiped off by means of a board or rule before closing the mold. This is still a very satisfactory method for simple shapes, and even now is used in many plants for most jobs. This technique is more suitably worked on a vertical press. Where a molding is very large, and the filling time is only a small fraction of the overall molding cycle, manual or semi-automatic methods are still the best to use.

Automation is warranted when parts are intricate in shape, are of reasonable size, have relatively thin wall sections, and are high production items. Such parts are best produced on a horizontal press, which offers rapid part ejection by knock-out pins in much the same fashion as in injection molding. The position in which molds are mounted controls the discharge of condensate from both mold halves.

Press types could change radically in the near future, depending on how successfully steam can be replaced

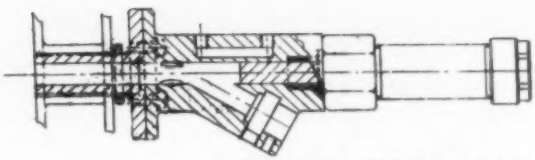


Diagram courtesy: Miller & Van Winkle Co.

Miller jacketed E.P.B. mold filler.

with R. F. heating methods. Dielectric heating has been tried by introducing a high-loss additive into the polystyrene compound. Here, the additive is heated by R. F., and transfers its heat to the resin by conduction.

Stan Rosen, chief engineer of Tronomatic Machine Co., recently showed me some of his company's multiple cavity molds for E.P.B. which had been designed for extremely high production in automatic press operations. A controversy exists between the designers of multiple and single cavity molds equipped with individual fill-valves, not as to which is the better method, but rather on the cost of a multiple cavity mold versus that of single molds with integral fill-valves (on an equal production basis). In my opinion, both types have merit since between them they offer the processor more latitude in his operations.

Four methods are used today to feed E.P.B. material: gravity feed, free venturi gun feed, integral venturi gun feed, and single venturi feed-multiple cavity. The first two methods are used only in manual or semi-automatic operations, the others with fully automatic set-ups.

The free venturi-gun feeder is always removed from the mold. A plug with a bayonet type lock or other

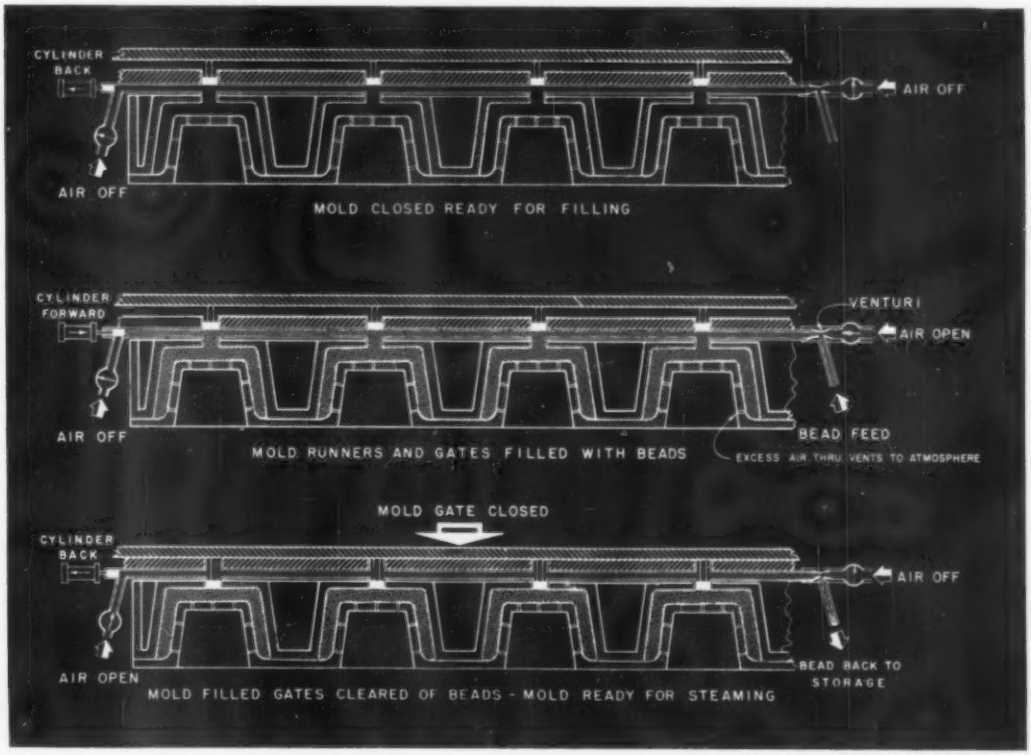


Diagram courtesy: Tronomatic Machine Mfg. Corp.

Multiple cavity mold, showing filling procedure.

(Continued on page 43)

ENGINEERING FORUM

Compression & transfer molding

Are you a short run thinker?

Continue your plastic education, try—Wisconsin

Edited by: PAUL E. FINA*

In my last article entitled "Selling with the Times" (January 1961), I emphasized the fact that the thermoset molder must continue to adapt himself to the changing times. In order to do this, he must continue his plastics education to remain abreast of modern developments. Plastics is a dynamic field, and the progressive molder needs up-to-date information. The molder who looks only for the applications he is accustomed to run is soon left behind. Too, it is important to think in the long run rather than just on a short-term basis. The economics of long- and short-run thinking frequently lead to quite opposite conclusions. To know future market requirements, results of the latest plastic research, and the most recent plastic technology, one must keep himself informed by reading, consulting, discussing, and attending plastic institutes.

Means of continuing a plastics education

The Education Committee of the Society of Plastics Engineers has rendered a tremendous service in setting up a suggested curriculum for the Universities and Colleges to train Plastic Engineers. As pointed out in their current "Program for Engineering Education in Plastics," the probable annual requirement for the industry is 400 new plastics-trained engineers. But the personnel who are presently actively engaged in the plastics industry, require constant attention. Both SPE and the Society of Plastic Industry conduct national and regional technical conferences. The SPE sponsors Professional Activity Groups (PAG) which deal with their particular segments of the industry. These "Groups" concentrate on mutual problems, furnish authoritative data, and extend engineering knowledge. In addition, there are many institutes being conducted by engineering schools and colleges for the "man in the field." Among these is the University of Wisconsin.

U of W—history and program

The University of Wisconsin began its engineering institute program in the school year of 1949-1950, organized under the Department of Engineering of the University Extension Division. The first plastic engineering institute was held in October of 1955. Since then, these two day meetings have been conducted at least twice a year. The attendance has grown to a high of 133 enrollees. Recently, the fall course was scheduled in November and the Spring Course is slated for the latter part of May (1961). Each program has a central theme, such as: "Developments in Plastics," "Plastics-Basic Chemistry and Technology," "New Opportunities With Plastics," and "Beyond The Horizon With Plastics."

The general format of the courses includes two speakers in the morning and afternoon periods, with coffee breaks between each pair of speakers. The one evening program is strictly social, including an informal dinner meeting and speaker. The subject matter of each course is usually determined by a survey of leading plastics personnel in industry. The speakers are also recommended through the survey. Thus, the program is timely, suited to the needs, and the speakers are well received.

Objectives of the U of W institute

The U of W program is designed to accomplish the following objectives: summarize the basic information on the subject for its refresher value; present information on late developments of practical, theoretical, and research origins; provide an opportunity for an exchange of information among the enrollees which would otherwise be difficult to obtain; and to pass on to the enrollees the material covered and the technique for further insemination when he returns to his place of employment. The above is a direct quote from a U of W booklet.

* Director of Sales Engineering, Fiberite Corporation

And now—thermosets!

Since the segment of the industry assigned to this particular Plastics Engineering forum is Thermosets, it is proper to conclude with the authors concept of what practical and useful subject matter should be included in an educational program particularly relating to thermosets. The outline listed below has been presented before (Plastics Technology, July, 1959) and though parts of it may apply to other branches in the plastics industry it is primarily concerned with thermoset molding.

1. Data sheet interpretation. The analysis of a data sheet by an engineer is important in order that he may make a proper selection. All phases of a data sheet should be understood and properly interpreted.

2. Estimating techniques. A molder should be able to estimate (a) piece-part weight; (b) establish cycle-time standard; (c) know how to determine the required number of cavities, molding pressure requirements, and press capacity. In addition, the estimator should know how to determine preforming charges, preheating costs and finishing expenses.

3. Molding conditions and molding techniques. There is much to be included in a course on preforming, preheating, molding pressures, plasticity of flow selection, molding temperatures, de-gassing, cure time derivation, solutions to molding problems, and the ways and means of holding close tolerances or dimensions (See Plastics Technology, Oct., 1960).

4. Mold-Die designing. The molding engineer should be cognizant of the various types of molds (flash, semi-positive, positive, landed dies, shear action, sub-cavity, pot transfer, and plunger), being used. Complete courses are needed in die lay-out, choice of tool steels, knock-out methods (pins, air-ejection, blow-out, etc.), plating, polishing methods, tool life expectations, and available standard die sets.

5. Piece parts design or redesign. To design properly, the plastics engineer must know how to redesign a piece part for plastic molding. Fillets, radii, angle for draw, potential parting line, etc., can influence and determine the final piece part design.

6. Available grades of thermosetting materials. The plastics engineer should know all the available types of thermosetting materials in order to make a proper recommendation. Each molding material may be suited for particular applications and in some cases overlap or compete with other materials in their function. The current familiar materials of the thermoset types are standard phenolic molding compounds of general purpose and high impact type, high temperature ablative phenolic compounds, melamine molding compounds (alpha-cellulose filled, fabric filled, glass filled), urea-formaldehyde molding compounds, polyester premix types, epoxy molding compounds, alkyd molding compounds, allyl molding compounds, etc. The properties of each of these materials should be studied carefully for their particular attributes.

Conclusion

It is my hope that the above article will be an incentive to the prospective plastic engineer and those who are already in the field. Let us attend the conferences, the institutes, and read everything available in the various magazines so as to be kept up to date with innovations and test results.

Note: For particulars on the U of W Plastics Engineering Institute write to Engineering Institutes, University Extension Division, 3030 Stadium, University of Wisconsin, Madison 6, Wisconsin. —THE END

Exploring Fabrication Techniques

(Continued from page 41)

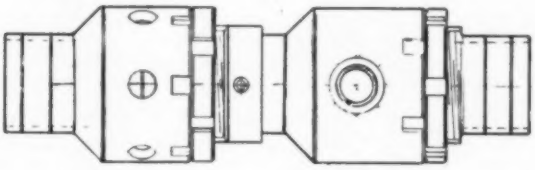


Diagram courtesy: Goulding Mfg. Co.

Goulding pressure relief E.P.B. filler.

locking device is used to close off the fill port. This method is used by many companies for mass producing all sizes of items.

In both semi-automatic and automatic operations involving complex shapes, the mold must be cracked open about 1/32 inch at the mating surfaces while filling. This prevents the transport air building up a back pressure which, in turn, can prevent beads from completely filling the mold. This operation is similar to the outgassing operation used in compression molding, and guards against voids occurring in the molded part.

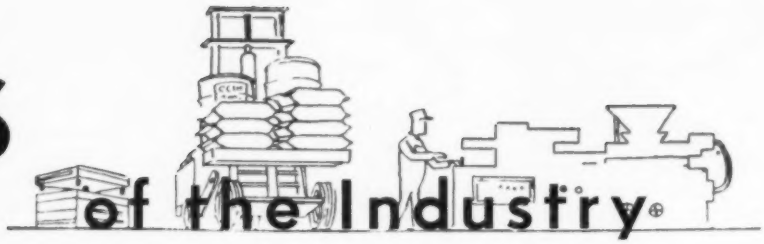
The Christmas tree base mold shown in the diagram was made for Ampco division of Creative Displays Inc., Jersey City, N.J., by Tronomatic Machine Mfg. Corp. The mold has cored holes on the main mold section instead of a steam chest. Steam tracing in this system will rapidly heat the mold, forming a high strength cohesive skin on the molded part. Since no steam holes are drilled into the mold from the cored holes, the surface of the part will remain unmarked. The main steam for fusion comes from the center probe, which is also the core piece of the mold. The remainder of the steam for fusion enters the mold through the flat sectioned steam chest.

•

Parison sticking

Any of you blow molders having trouble with the parison sticking to the die?—Try using five mil Teflon tape treated on one side for adhesive application. After cleaning and slightly roughing the steel surface, adhere the tape to the lips of the die with any good epoxy type, or B. F. Goodrich PL-604 cement. A more permanent method would be to have the lips of the die coated with Teflon to a minimum depth of two mils. The following is a short list of companies specializing in Teflon coatings: General Plastics Co., Bloomfield, N.J., Industrial Plastic Coating Co., Clifton, N.J., and Glaco N.J. Co., Fairlawn, N.J. —END

NEWS of the Industry



agents, distributors & agreements

American Cyanamid Co. has been licensed by Imperial Chemical Industries, Ltd., to manufacture methylmethacrylate. A production unit will be built at the Fortier plant near New Orleans.

American Vulcathene Division, Nalge Co., will handle sales and distribution of York Industrial Plastics' Penton-clad steel pipe and valves.

Borden Co. and U. S. Rubber Co. have announced the formal organization of Monochem, Inc., a jointly owned firm which will build a major chemical complex in Baton Rouge for the conversion of hydrocarbons.

B. F. Goodrich Industrial Products Co. has established 14 authorized manufacturers to produce and sell combination storm windows and doors fabricated from rigid Koroseal vinyl extrusions.

Shawinigan Chemicals, Ltd., Canadian Resins Division, has been appointed distributor for Marlex high-density polyethylene and copolymers produced by Phillips Chemical Co.

Whitlock Associates, Inc., Oak Park, Mich., has appointed Freeman & Co., Dearborn, Mich., as its representative in Michigan and northern Ohio.

business developments

Acme Resin Corp. has completed new headquarters at 1401 Circle Ave., Forest Park, Ill. Previously used office space has been converted to research and development.

AviSun Corp. recently introduced its oriented polypropylene film, Olefane U. The film should be available in commercial quantities within the next few months.

Dow Chemical Co. plans to manufacture several types of rigid plastic containers to expand its participation in the packaging industry.

General Foam Corp. announced that bumpers and play pen pads will now have urethane foam cushioning.

Heyden Newport Chemical Corp. has introduced a line of liquid and resinous curing agents for epoxy resins, as well as viscosity modifiers.

change in corporate name

Lord Chemical Corp., York, Pa., becomes the Lord Chemical & Equipment Division of Wheelabrator Corp.

Tri-Point Plastics, Inc., is now operating under the new name of Tri-Point Industries, Inc. The Albertson, N.Y. firm extrudes and processes Teflon.

changes in address

Charles J. Wiegel, Inc., has moved from Detroit to Holland, Mich. It will be located next to another Chemetron subsidiary, Holland Color & Chemical Co., which it supplies with varnishes, dispersed blacks, and driers.

DuPont's dyes and chemical division has transferred its New York district sales office, lab, and warehouse to Clifton, N. J.

Price-Driscoll Corp., manufacturer of Super King Bomb-Lube mold lubricant, has moved to 75 Milbar Blvd., Farmingdale, N.Y.

Price-Driscoll Corp., manufacturer of Bomb-Lube mold lubricant, has moved to 75 Milbar Blvd., Farmingdale, N. Y.

Univis Lens Co., manufacturer of eyeglass frames and plastic lenses, has moved from Ohio to Fort Lauderdale, Fla. The firm also announced a name change to Univis, Inc.

changes in ownership

Bemis Bro. Bag Co. has acquired controlling interest in Air-Formed Products Corp., Nashua, N.H., blow molder.

Canford Mfg. Corp., Canton, Pa., has purchased the machinery, tools, and assets of Klear Plastics, Inc., Quakertown, Pa. The latter firm, a maker of lids for the food industry, will continue operations as a Canford division.

Consolidated Pipe Co. has acquired the pipe fittings division of Gulf Stream Plastics, Inc., Hialeah, Fla. Equipment, molds, and inventory have been moved to the injection molding division of Consolidated in Akron.

Eldon Industries, Inc., Hawthorne, Calif., has purchased the assets of Knickerbocker Plastics division, North Hollywood.

Electronic Plastics Co. has been acquired by Dynacron Electronics Corp., a wholly-owned subsidiary of Trans-United Industries, Inc. The firm will be located in Richmond Hill, N. Y.

new plants, labs & additions

American Cellular Corp. has expanded its facilities at 8501 S.W. 129th Terrace, Miami, and is now manufacturing a proprietary line of plastic bottles, 8 ounce through 1 gallon in size.

Amos-Thompson Corp., Edinburg, Ind., has added 19,000 square feet to its molded plastics division.

Barron Plastics, Inc., has occupied a new building at 100 Barron Drive, Woodlawn, O. In addition to its molding operations, the firm is an authorized Plexiglas dealer.

Borane Chemical Corp. has completed a pilot plant for the production of diallyl terephthalate, diallyl pyromellitate, and a number of boron monomers. Plant site is Montebello, Calif.

Canford Mfg. Corp., Canton, Pa., a subsidiary of Stanley Home Products, has opened a 30,000 square foot injection molding plant. Peter Geanacopoulos is plant manager.

Chemplast, Inc., has doubled its plant space in East Newark, N.J., to 32,000 square feet. The firm molds, extrudes, and machines Teflon.

Dow Chemical Co. is building a second polyolefin plant at Plaquemine, La., utilizing an improved Ziegler type linear polyethylene process which they developed. The Torrance, Calif., polypropylene plant is now officially on stream.

Ferro Corp. recently completed a $50,000 colorant plant and warehouse in Elizabeth, N. J.

General Electric's laminated products department has set up a South Atlantic district sales office in Greensboro, N. C., to market Textolite laminates. Lou A. Merritt will direct the operation.

Hercules Powder Co. opened its second polyolefin plant on April 6. Located in Lake Charles, La., the plant has a capacity of 60-million pounds per year. Construction is still going on for another 60-million pound unit at the same site. The percentages of polyethylene/polypropylene can be varied as dictated by current demands.

Injection Molders Supply Co., Inc., has more than doubled its facilities through its move to 17601 South Miles Road.

Kautex Machines, Inc., now has its own plant at 536 East Elizabeth Ave., Linden, N.J., and will carry a full supply of spare parts and technical service facilities. The firm is the American representative of Kautex-Werke Reinold Hagen, Hangelar/Sieburg, West Germany.

Lamtex Industries, Inc., Farmingdale, N. Y., has acquired 14,000 square feet of additional plant space. The firm manufactures reinforced plastic structures.

Lasco Industries, Inc., reinforced plastic panel and pipe manufacturer, has consolidated its multi-plant operation in a new 54,000 square foot plant at Montebello, Calif.

Northwest Plastics opened a 25,000 square foot plant in Grundy Center, Ia., for its wholly-owned subsidiary, Plastronics, Inc. The new plant will employ over 100 people on three shifts.

Swift & Co. has expanded in the epoxy field and is constructing a major addition to its epoxidation plant in Hammond, Ind.

new plastic companies

Summit Plastic Industries, Inc., is a recently established laminating and coatings firm located in Summit, N.J. The firm will also specialize in such product line as expanded vinyl foam and polyurethane laminations.

Edward Yellin has severed all connections with the Bernard Edward Co., Kolmar Mfg. Co., and Panhandle Plastics, Inc. He has formed a new firm —Edward Development Co., with offices at 30 N. Michigan Ave., Chicago. This company will be a consultant firm and will develop various plastic processes and products.

news from abroad

Austria. Lignin can be decomposed and entirely new high polymers built up of the low molecular fractions, according to Prof. K. Kratzl of Vienna University.

Brazil. Polidura do Brasil, S.A., Sao Paulo, is producing polyesters under license from American Alkyd Industries under the tradename Pebetron.

Czechoslovakia. Plastic material production reached 53,000 tons in 1959, a 500% increase over 1950. Practically no polyethylene was produced; however, plants are being built and 1965 figures are expected to reach 150,000 tons. A new process is claimed possible of producing blocks of nylon large enough for big machinery components and structural elements like keels for ships.

Netherlands. Research Institute T.N.O., Delft, has developed a panel for boxing in the casting of concrete building elements. It consists of a plastic skin on a support of plastics-impregnated fibrous material which is both waterproof and flexible.

Names in the News

Ennis P. Whitley

Ennis P. Whitley, vice president for distribution of Dobeckmun Co., has retired after 16 years with the company. A vice president for nine years, he joined the company as general sales manager in 1945.

Sherman K. Reed has been appointed director of research for Food Machinery and Chemical Corp.'s chemical divisions. Formerly research and development director of the company's chemicals and plastics division, Dr. Reed will be succeeded in this position by **Dr. John A. Garman,** manager of organic chemical research at FMC's Baltimore, Md., laboratory.

Joseph G. Nemeth has been appointed vice president, and **William G. Ficken,** sales manager, at Insulating Fabricators, Inc. Mr. Nemeth has been with the company since 1947 and is active in engineering and sales work. Mr. Ficken has been employed as a salesman since 1951.

G. M. Juredine, Battelle consultant and former division manager with Harshaw Chemical Co., has joined Synthetic Products Co., Cleveland, as vice president, sales.

Nathan M. Miksch

Newark Die Co. has announced the election of **Nathan M. Miksch** as president. With the company since 1945, he was formerly treasurer. **Victor P. Bergquist** and **Ernest J. Csaszar** have also received new appointments, Mr. Bergquist as plant manager and Mr. Csaszar as director of sales. The former has held several production posts since joining Newark Die in 1934. The latter, now in charge of all sales and marketing for Newark Die and its subsidiary, Newark Die Hobbing and Casting Co., has been manager of sales for the past four years.

Norbert H. Kirchgessner has been moved up from technical supervisor, plastics, to production superintendent, chemicals, at the North Tonawanda, N. Y., plant of Durez Plastics Division, Hooker Chemical Corp. Mr. Kirchgessner succeeds **Jay P. Eggers,** recently promoted to works manager of Durez's new synthetic phenol plant near South Shore, Ky.

Douglas Mueller, assistant to the president of Seiberling Rubber Co., has been named director of merchandising and public relations. He joined Seiberling's advertising department in 1941.

Henry L. Ford

Dr. L. K. Eilers

Henry L. Ford has been elected president of Eastman Chemical Products, Inc., succeeding **L. K. Eilers,** who has become vice chairman of the board of directors. Mr. Ford, a vice president of Tennessee Eastman and Texas Eastman since 1958, has been with Tennessee Eastman since 1922. Dr. Eilers, also first vice president of the two divisions, has been connected with them since 1959.

David Markowitz, former staff process engineer for the butadiene division of Koppers Co., has joined Foster Grant Co., Inc., as assistant manager of the polymer division. At Koppers, he also held positions as manager of engineering and manager of product development.

Several management promotions have been announced by Insulation Manufacturers Corp. **Edward B. Finn** is senior vice president. At general offices in Chicago, **Bernard F. McNamara** is executive vice president in charge of the merchandising division; **J. Harold Martin,** executive vice president for Inmanco manufacturing division; and **Stanley W. Jarosz,** manufacturing vice president. **Stephen L. Kubala** has been appointed assistant treasurer, and **Paul K. Wolfram,** sales manager.

Sam Larner has joined Olympic Plastics Co., Inc., as manager of the reinforced plastics division. He was with Radioplane for the past five years.

Norton C. Wheeler, Jr., has been appointed research and development manager of Davis-Standard, Division of Franklin Research and Development Corp. A sales engineer for the past 12 years, he will be concerned with development of high-production extrusion operations.

Kenneth E. Pettijohn

Kenneth E. Pettijohn has been elected president of Space Structures, Inc. A partner in the accounting firm of Norberg and Pettijohn, he had previously served as secretary and treasurer of SSI, and will continue as secretary. At the same time, **A. A. Anderson,** former president, was named chairman of the board; **Philip S. Duff** named a director; and **Maurice H. Rieke** named treasurer.

Helmut Zeiss is representing Plastic Extruded Products Co. in technical sales in New Jersey and eastern Pennsylvania.

Bernard D. Ashbaugh

Bernard D. Ashbaugh is directing sales of plastics molding machinery for Farrel-Birmingham Co., Inc., Watson-Stillman Press Division, as manager of plastics equipment. He had been associated with Hydraulic Press Manufacturing Co. for twenty years.

OBITUARY

Ferdinand B. Savarese, director of laboratories for Advance Solvents & Chemical, New Brunswick, N.J., died suddenly on January 3, 1961, at the age of 44. Death was the result of a coronary thrombosis.

A member of the American Chemical Society, Mr. Savarese had worked for Advance Solvents for more than 16 years.

New Materials

For more information check Readers' Service Card (p. 69)

Flame-retardant polyester

A flame retardant fiberglass-polyester premix is now being offered to molders of electrical insulating parts by Glastic Corp. According to the company, Grade 1506 molding compound has high impact strength and good moldability in deep draw parts. It can be used in most existing molds.

The following characteristics are claimed for this medium impact material.

Impact strength, Izod notched, ft. lb./in.	6
Flexural strength, psi	15,000
Tensile strength, psi	7,000
Compressive strength, psi	20,000
Water absorption, % in 24 hrs./23° C.	0.1
Heat distortion temperature, 264 psi., °F.	300
Flame retardance, sec. ign./sec. burn	85/85
Arc resistance, seconds	130
Dielectric strength, S.T., perp. vpm	350
Dissipation factor, 60 cycles	0.03

The red material, when molded, has a specific gravity of 2.2. Shelf life at 85° F. is 30 days.

Readers' Service Item 1

Iron oxide pigments

Columbian Carbon Co. has introduced two pure iron oxide pigments, yellow low opacity and red low opacity. They are transparent and non-toxic. When mixed with white pigments, red low opacity develops a salmon color. The yellow Mapico pigment provides bright shades. Transparency is due to fine particle size.

These dry pigments can be dispersed in all media.

Readers' Service Item 2

Fluorohalocarbon compounds

Two fluorocarbon molding and extrusion compounds, VK and TVS, have been developed by Allied Chemical Corp.'s plastics division, and are expected to be commercially available later this year. To be marketed under the name Halon, the resins show typical fluorocarbon properties, notably chemical inertness and wide temperature resistance. They are serviceable up to 390° F., flexible in thin sections at —320° F., and transparent in sections up to ⅛-inch thick.

Among applications seen for the materials are milk packaging equipment, electric cable jacketing, antiseptic medical equipment, chemical gasketing, and electrical components where moisture absorption is a factor.

The compounds show high volume and surface resistivity at high and low temperatures. At high temperature and high frequency, they possess low dielectric constant and good power factor. Radiation resistance is good. Type VK was not affected by sunlight after outdoor weathering for over a year. Tests now being run on TVS are expected to show similar weather resistance.

The degree of crystallinity of these polymers is controlled to some extent by treatment during processing. For example, rapid quenching of the resin melt yields many small crystals and a tough, transparent, and comparatively flexible product, while slow cooling may produce a more rigid and more opaque part.

Some properties of the two resins are:

	VK	TVS
Specific gravity	2.1	2.16
Tensile strength, psi., 70° F.	4,300	—
75° F.	—	4,970
212° F.	1,300	3,300
280° F.	240	250
Compressive yield, 77° F., psi.	4,600	7,400
Flexural strength, 77° F., psi.	7,400	9,300
Impact strength, Izod, 77° F., ft. lb./in. notch	27*	4.7
Hardness, Rockwell R.	75	95
Elongation, %, 75° F.	150	205
Thermal conductivity, btu/ft.² hr./°F./in.	1.5	1.37
Coefficient of linear expansion, in./in./°C.	7.2×10^{-4}	4.77×10^{-4}

Readers' Service Item 3

Acetate for sheet extrusion

A formulation of Tenite acetate for extrusion into clear transparent sheet that will not cloud or haze during vacuum forming is available in commercial quantities from Eastman Chemical Products, Inc. Especially suited for blister, bubble, and skin packaging, the thin-gage sheet showed no blushing, clouding, or hazing in experimental deep drawn sections.

Formula 081 can be extruded on conventional sheet equipment. Flows range from H to H_4.

Readers' Service Item 4

Thermoplastic antistatics

Arnold, Hoffman & Co., Inc., is offering several antistatic agents for incorporating into thermoplastic materials. Currently being offered are: Ahcostat PX for polyethylene, AL_5 for PVC, and SB for polystyrene and acrylics.

PX is incorporated into polyethylene during manufacture or conversion. Aluminum silicate added to the injection molding master batch will further improve antistatic and processing qualities. Ahcostat for PVC is a stable liquid, exerting a slight plasticizing effect, which can be incorporated in plastisols, organosols, or rigid compositions. Ahcostat SB can be sprayed, dipped, or wiped on acrylics and polystyrenes. Soluble in water, it will last six to nine months under ordinary conditions.

Readers' Service Item 5

Fiberglass surfacing mat

According to Famco, Inc., its new surfacing mat incorporates the handling characteristics of a surfacing mat and the molding characteristics of a veil.

Type 500-H surfacing mat is recommended for use in deep-drawn or complexly shaped parts. It is claimed not only to form readily, but to save material and handling. It can be separated easily when stacked, and when it is used, molders do not have to slip sheet each piece. Type 500-H comes in uniform thicknesses of 5, 10, 15, 20, and 30 mils with a polyester binder and silane finish.

Readers' Service Item 6

Fluorescent pigments

Advance Process Supply Co., Inc., is marketing fluorescent colors for screen process printing on any material. Under the name Lumi-Glo, the fluorescents can be used for indoor and outdoor poster colors, weatherproof gloss enamel colors, as well for pigments for thermoplastics and some thermosets.

Readers' Service Item 7

Epoxy materials

Isochem Resins Co. has recently announced several new products. Isochemstrip 708, an epoxy stripper, is a thixotropic dip that quickly disintegrates resin without damaging metal leads or components. It may also be painted on epoxy-coated surfaces.

An epoxy adhesive, Isochembond 811B, comes with three hardeners for ease in application. With a viscosity of 90,000 cps., this material supplies a tough metal bond with high heat stability.

For protection of wire leads or parts during epoxy or other resin coating, Isochemmask can be applied. This liquid vinyl resin material can be dipped or wiped on, after which it dries at room temperature. It can be removed through application with a solvent.

Readers' Service Item 8

Single-component epoxy

A 100% solids, epoxy, single component coating for continuous operation to 155° C. has been announced by Columbia Technical Corp. Humiseal 1F56 requires no mixing with hardeners and may be used directly from the container. This rigid system is curable at elevated temperatures. Viscosity may be adjusted to yield builds of ten mils and thicker.

Readers' Service Item 9

High density polyethylene

Three formulations of Ameripol high density polyethylene resin are being produced commercially by Goodrich-Gulf Chemicals, Inc. The resin is produced in a plant designed around Goodrich-Gulf's development of a Ziegler activated catalyst system. The formulations are claimed to be outstanding in environmental stress cracking resistance and in temperature embrittlement resistance. They are processed like other high density polyethylenes, and are especially applicable for extruded pipe and insulation and blown articles.

Density of all three materials is 0.95. The succeeding properties have also been reported.

	Ameripol 32	Ameripol 34	Ameripol 35
Melt index, g./10 min.	0.1–0.2	0.04–0.08	0.0001
Flow index, g./10 min.	24.0–28.0	8.5–9.3	4.0–5.6
Intrinsic viscosity	2.3–3.0	3.1–3.7	3.8–4.8
Vicat softening temperature, °C.	119	121	122
Ultimate tensile strength, 20 ipm., psi.	2,250	2,450	2,700
Tensile at yield, 20 ipm., psi.	3,450	3,450	3,450
Elongation, 20 ipm., %	120	320	560
Impact strength, ft. lbs./in. notch			
⅛ x ½ bar	19	31	36
¼ x ½ bar	8	17	24
½ x ½ bar	0.9	1.9	4.3
Stiffness in flexure, psi.	115,000	115,000	120,000
Hardness, Shore D	60	60	60
Environmental stress cracking, hrs.			
With antioxidant	65	445	>800
Without antioxidant	40	230	500
Thermal embrittlement, hrs.			
With antioxidant	185	>1,000	>1,000
Without antioxidant	70	95	700
Dielectric strength, 25° C., volt/mil	1,100	1,100	1,100
Dielectric constant, 25° C., 60 cps.	1.82	1.82	1.82
Dissipation factor, 25° C., 60 cps.	0.00017	0.00017	0.00017
Volume resistivity, ohm/cm.	7×10^{15}	7×10^{15}	7×10^{15}
Insulation resistance, ohm/1000 ft.	164,000	67,500	118,000

Readers' Service Item 10

for the reinforcement of

PLASTICS

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Polypropylene formulations

The most recent company to join the ranks of polypropylene producers is Eastman, which will complete a plant for commercial production very shortly. Several formulations of Tenite polypropylene, in a wide range of flow rates, will be commercially available within the next few months.

Manufactured in a continuous process, Tenite polypropylene has a nominal density of 0.91. Like other polypropylene compounds, it can be molded into products which have a built-in hinge. The hinge effect is made possible by the fact that the material will orient at a temperature far below the glass transition point. The oriented fibers at the area of bend provide sufficient strength to make the hinge feasible.

The material is claimed to excel in moldability, especially in difficult-to-fill molds. Corners, however, should be filleted rather than squared. In some cases, Tenite polypropylene can be molded at lower melt temperatures than other polypropylene resins with similar flow rates.

Four general purpose and three high-impact formulas of the polypropylene have been developed. Modifications of these can be made for extra heat endurance, ultraviolet resistance, or oxidation stability. Measured in grams per ten minutes at 230° C. and 2.16 kilogram load, the general purpose resin flow rates range from 2.5-18, and the high-impact flow rates from 3-1. Additional properties of injection molded samples are below.

	General Purpose	High-Impact
Softening point, Vicat, °C.	149	145–135
Brittleness temperature, °C.	—	0 to —40
Tensile strength at upper yield, psi.	4,900	4,400–3,300
Stiffness in flexure, psi. x 10^5	1.5	1.4–1.0
Rockwell hardness, R scale	95	85–45
Izod impact strength, 23° C., ft. lbs./in. notch	0.5	1.5–15
Unnotched	16	Did not break
Dielectric constant at 100 kc./sec.	2.3	2.3
Dissipation factor at 100 kc./sec.	0.0003	<0.0005

Readers' Service Item 11

Phenolic varnish

According to Colab Resin Corp., it may be possible for impregnators and laminators to eliminate the mold cooling cycle and to operate at lower pressures by using a phenolic varnish CR-301 for impregnating paper, canvas, asbestos, glass, etc.

Products made with CR-301 are claimed to have low moisture absorption high chemical resistance, and increased mechanical and impact strength.

Readers' Service Item 12

Heat-resistant organic fiber

Minnesota Mining & Manufacturing Co. has announced an organic, heat-resistant fiber which retains its flexibility and part of its strength after exposure to intense heat. Pluton fiber is available as a fabric and can be worked into phenolic laminates to form structural parts or molding compounds. It conducts very little heat or electricity: after ten minutes at 1,300° F., resistivity was greater than 100 megohms.

The fiber has a tenacity of 0.8 grams per denier and a specific gravity of 1.45. Potential uses for the fabric are missile motor case liners, insulation in jet aircraft, fire-protective curtains, etc. As a laminate in an approximately 50-50 combination with phenolic, the fiber is suitable for structural parts which must withstand intense heat. It is presently being tested for rocket engine parts.

According to the company, Pluton has withstood temperatures of about 18,000° F. without melting. In one demonstration, molten steel, 3,000° F., was allowed to harden on an unsupported piece of fabric. The steel solidified without burning the fabric.

Pluton fabric is currently available in a satin weave (5 oz./sq. yd.), a single ply plain weave (8 oz./sq. yd.), and a two-ply plain weave (12 oz./sq. yd.).

Readers' Service Item 13

Three mold releases

Surfak, a non-silicone parting and release agent, can be used on all surfaces which contact thermosetting materials. This non-flammable material distributed by Gibraltar Industries Inc., will not complicate finishing operations. It reportedly aids in preventing rust and corrosion.

Readers' Service Item 14

Rulon spray, a reinforced fluorocarbon anti-stick and mold release agent, is supplied in six-ounce aerosol cans by Dixon Corp. Like Surfak, it can be used where painting, plating, and hot stamping follow the molding operations. Rulon spray reportedly dries instantly, without leaving a gummy or oily film, and will last for several cycles. Chemically inert, insoluble, and thermally stable to over 500° F., it may be used in all plastics molding applications.

Readers' Service Item 15

Rainville Co., Inc., is now marketing a silicone mold release for surface parting or lubrication. It is supplied in an aerosol can.

Readers' Service Item 16

How SANTICIZER® 409 gives vinyl products high-priced properties at the lowest cost of any premium polymeric plasticizer

PERFORMANCE: SANTICIZER 409 *stays put.* Its compatibility-stability is superior, under highly humid conditions, particularly when formulated with heat-stabilizing epoxy plasticizers. SANTICIZER 409 stubbornly resists migration to polystyrene—and to both natural and synthetic rubbers—as well as extraction by solvents. Stability to light and heat is exceptional. There's hardly a trace of odor or color.

PROCESSING: The good solvating action of SANTICIZER 409 can boost your output, too. Promotes fast fusion and extrusion. Helps prevent "fisheyes," roughness, and pinholes.

PRICE: SANTICIZER 409—*at 4¢ to 6¢ per lb. LESS than other premium-quality polymerics*—imparts top-quality performance to many kinds of vinyl products.

PROOF: Try it . . . "on paper," in the laboratory, in the plant. Compare SANTICIZER 409 with *any* other polymeric plasticizer (price, properties, stability, ease of processing). You will see that SANTICIZER 409 gives *more profit per unit volume of vinyl compound.*

FACTS: Technical Bulletin PL-409 gives complete performance data—including specific details on how SANTICIZER 409 can help you make:

- **105° wire compound with exceptional electrical properties and retention of elongation.**
- **permanent, adhesive-backed film.**
- **migration-resistant, low-odor refrigerator gasketing.**

Monsanto

Monsanto Plasticizer Council . . . for plasticizer guidance that pays!

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Organic Chemicals Division
Plasticizer Council, Dept. 4410-A
St. Louis 66, Missouri

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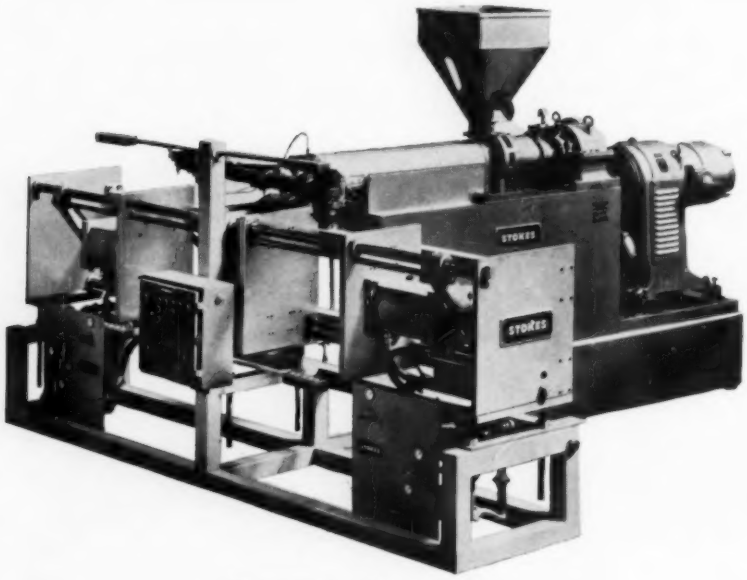
New Equipment

For more information check Readers' Service Card (p. 69)



Five-gallon blow molder

F. J. Stokes Corp. has developed a dual manifold blow molding machine which will produce items as large as five gallon containers from polyethylene, styrene, and other thermoplastic materials.

Model 856 is designed to make efficient use of the full output of a 3½-inch extruder. The large platens, providing 550 square inches of molding area, will handle pieces up to 30 inches long. One cylinder actuates the movement of the two platens for each molding station, assuring a uniform closing rate. A special linkage equalizes movement of the two platens so that they clamp at the exact center line of the molding position.

The clamping and molding section can be raised, lowered, advanced, or retracted so that the die can be precisely adjusted in relation to the manifold openings. Since cooling water connections are at the rear, the space under each molding station is free for downward ejection or removal of moldings.

Two optional attachments can be provided. One, a dual extrusion crosshead, delivers two parisons at each clamping position. The other, an accumulator, is fitted into the manifold delivery line and will hold up to four pounds of material. Use of the accumulator permits the full shot to be delivered in three seconds, in comparison with the normal delivery rate of 20 seconds. This minimizes necking down.

The blow molder can be purchased with or without the extruder. Following are the main specifications.

Clamp at 100 psi., tons	5
Stroke, each platen, inches	13
Daylight, mold open, inches	28
Platen dimensions, depth x height, inches	20 x 27½
Mold area, inside tie rods, inches	12 x 17½
Maximum mold length, inches	36
Mold length clearance, inches	50
Maximum part diameter, inches	12¾
Maximum part length, inches	30
Dry cycles per hour	1,000
Height, floor to center line of extruder, inches	60
Space between centers of orifices, inches	42
Overall dimensions, width x height, inches	140 x 66

Readers' Service Item 21

Bow expander roll

Among the uses of the bow expander roll is the removal of wrinkles from cast film by spreading it. Rodney Hunt Machine Co. has introduced an expander which uses a thin film of water as a bearing.

The Aquatrol expander has only one moving part, a rotating rubber sleeve which can be replaced by the operator. Almost frictionless rotation is enhanced by the sleeve's floating in a film of water to give uniform, smooth, spreading action over the entire face.

The rolls are now being made 3½-4½ inches in diameter up to 175 inches in face, as well as to customer requirements. Because of near frictionless operation, applications to date have required no drive.

Readers' Service Item 22

Cylindrical heating unit

Thermel, Inc., is manufacturing and selling the Thermaroll, a cylindrical heating element for use in continuous processing of laminates, embossed materials, and heat sealable films.

The unit is supplied with electrical radiant transfer heat and equipped with dual thermocouple temperature control. It is also available with solution transfer medium. Temperatures run from 275-1,000° F. The chrome plated sheath comes in outside diameters of 6-30 inches.

Thermaroll sheath & heating element.

Readers' Service Item 23

Double Ribbon Blender

The Falcon double ribbon blender, engineered for mixing powders, granules, pastes, or liquids, is reported to have been successfully used in dry blending PVC and other plastic compounds.

The blenders are manufactured in carbon and stainless steel alloys in capacities from 10-400 cubic feet. Welds are ground smooth to prevent contamination. The ribbons, mounted in a removable assembly for easy cleaning, have rounded interior corners. The company can also supply plasticizer spray pipes.

Seals at the shaft are single, Teflon rings. At the discharge, Teflon-gasketed plug type gases or dust and leak proof paddle type gates can be accommodated. Special modifications or sizes will be fabricated by the supplier, Falcon Mfg. Div. of First Machinery Corp.

Readers' Service Item 24

Metal detector

A metal detector which locates ferrous and non-ferrous metal particles in nonmetallic materials is especially recommended for plastic sheet and film processing. Electro-Mechanical Research, Inc., claims that its model 200 A detector features unusual stability, despite changes in atmospheric conditions.

Model 200 A can be used with conveyor belts up to three feet wide. It will detect ferrous particles larger than 0.063 inch and non-ferrous particles larger than 0.085 inch at conveyor speeds of 1-100 feet per minute. The coil system, comprising a fixed and a movable head and providing inspection apertures up to 11 inches, is separate from the dust proof electronic control box.

Readers' Service Item 25

Also Worth Mentioning—

☐ Cooler and quieter operation are claimed to be the main features of two- and three-way solenoids valves manufactured by Allied Control Co., Inc. They are available in normally open or normally closed types, ¼ or ⅛ inch pipe sizes, A-C or D-C, conduit or grommet housings. The valves were designed for higher pressures and greater flow.

Readers' Service Item 26

☐ Finn and Fram, Inc., has developed an extra wide glass roving cutter with rolls 10-60 inches long. Designed for panel manufacture or tonnage cutting, capacity is four pounds per minute per inch of roll width. Rolls may be adjusted to a fixed position or roll pressure may be maintained with air cylinders. Speed is adjustable.

Readers' Service Item 27

How MOD-EPOX® liquefies viscous epoxy resins and "liquidates" some of the cost

PERFORMANCE: Reactive MOD-EPOX reduces epoxy resin viscosity as much as 75%, combines *chemically* in the curing to become part of the resin. This means you can use more filler, yet have faster flow, less entrapped air, fewer rejected finished parts. And final properties are actually *improved:*

FLEXURAL STRENGTH OF 4-PLY GLASS FIBER-EPOXY LAMINATES (ASTM D638)

FORMULATION:	Control	with MOD-EPOX
MOD-EPOX	—	25
liquid epoxy resin	100	100
diethylenetriamine	12	8
magnesium oxide (fluffy)	—	0.25
FLEXURAL STRENGTH:	**psi**	**psi**
original	42,400	48,400
ketone—40 hrs. @ room temp.	42,400	47,700
water—40 hrs. @ 100°C.	29,400	37,600
10% caustic—27 hrs. @ 100°C.	8,500	9,200

Epoxy resins modified with MOD-EPOX for better flow and lower cost show better dimensional stability—lower power factor—equivalent hardness—and higher adhesive strength (*shear bond strength of a standard epoxy adhesive increases more than 50%, steel-to-steel*).

ECONOMY: NOW . . . MOD-EPOX at 36¢/lb.* costs less than any grade or brand of epoxy resin, 50-75% less than most other modifiers . . . AND reduces the curing-agent requirements to about ⅔ of usual amounts.

FACTS: Technical Bulletin PL-313 gives complete performance data—including specific details on how MOD-EPOX can help you make:

- **easy-handling electronic potting compounds.**
- **low-cost auto-body-solder formulations.**
- **high-strength casting and encapsulating compounds.**
- **tenacious adhesives for metals and glass.**

*T/L and C/L, F. O. B. Monsanto, Illinois

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Plastics Applications

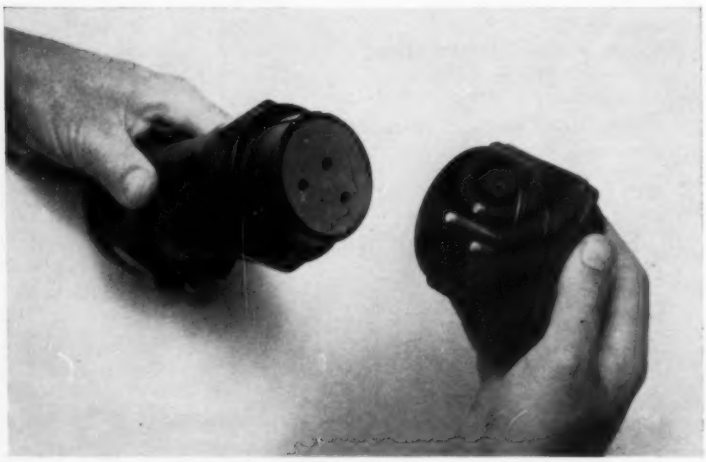
For more information check Readers' Service Card (p. 69)

Musical toy

The Magic Music Box incorporates rods for hand playing and metallic xylophone bars for hammer hitting. Manufactured by Plastic Injecto Corp., this musical toy comes with 12 song sheets which, when placed under the golden rods, show the child which string to strike.

The blue and gold music box is molded of Koppers Dylene Polystyrene.

Readers' Service Item 41



Connector Insulators

Diallyl phthalate insulators are being molded by Crouse-Hinds Co. for use in circuit-breaking electrical connectors. The Ark-trol electrical connectors are reported to insure high capacity peformance under severe temperature and humidity conditions. The redesigned insulators are only half as large and a fifth as heavy as earlier models.

The connectors will perform in temperatures from −80° to 225° F., and under pressures of 300 psi. external and 200 psi. internal. The series has an electrical capacity range of 30-200 amp. at 600 V. A. C.

Food Machinery and Chemical Corp. supplied the Dapon diallyl phthalate on which the molding compounds were based.

Readers' Service Item 42

Nylon turbine wheel

The turbine attachment on Sunbeam Corp.'s Dual De Luxe vacuum cleaner is driven by a nylon fan wheel. The turbine brush was designed to combine the advantage of the power driven brush of an upright vacuum cleaner with the flexibility of a tank cleaner.

The brush is powered by a Zytel nylon fan consisting of 54 curved blades spaced to allow intake of such objects as hairpins. The Du Pont resin is injection molded in one piece for this application by Chicago Molded Products Corp. The material was selected because it had high strength in thin section, resilience, and resistance to metal impact and abrasion.

Readers' Service Item 43

Fiberglass-polyester bicycle

Bomard Industries, Inc., is producing and marketing a reinforced plastic bicycle. Designated the Bowden Spacelander, the bicycle is molded from polyester resins produced by Reichhold Chemicals, Inc., and fiberglass from its subsidiary, Modiglass Fibers, Inc. Mechanical parts are enclosed to prevent corrosion.

The bicycle comes with chrome plated rims, spokes, and handlebars. Its construction reportedly prevents possible accidents to the rider and his clothing.

Readers' Service Item 44

Dishwasher Water Distributor

The "Z" shaped water distributor in the Waste King-Universal portable dishwasher is fabricated from coral-colored polypropylene. Industrial Molding Corp. injection molds parts of the distributor, and then heat welds them into the unusual configuration.

Molded of Hercules Powder Co.'s Profax polypropylene, the distributor replaces stampings, castings, and stainless steel parts. It enables the appliance to wash dishes both from the top and the bottom.

Waste King water distributor.

Readers' Service Item 45

Extruded Corrugated Vinyl

National Rubber Machinery Co. and B. F. Goodrich Chemical Co. have jointly announced continuous extrusion of corrugated translucent vinyl sheet from Geon 82304. Designed for structural glazing and internal partitioning, the sheet is extruded using a 52-inch wide sheet die and a post corrugating form positioned in tandem with the extrusion die. More than 700 square feet of 1/16-inch thick sheeting can be extruded in an hour.

The development is reported to make rigid vinyl glazing competitive with other corrugated plastic sheeting. Because corrugations run in extrusion direction, panels of any length may be produced.

Readers' Service Item 46

Styrene Diffusing Sheet

Sheffield Plastics, Inc., has developed a medium impact, self-extinguishing styrene for use in ceiling installations. Frost-White-SE is claimed to have color stability and light transmission characteristics superior to those of vinyl sheet. The sheet is color stable up to 50,000 fluorescent lighting hours, and transmits as much light at 0.025-inch thickness as the competitively priced 0.015-inch vinyl sheet. The greater possible thickness reportedly provides easier handling and greater rigidity.

The material passes the requirements of the New York City Building Code, Group A, and the Group 2 test of the Underwriters' Laboratory for self-extinguishing plastics.

Readers' Service Item 47

Also Worth Mentioning—

☐ By covering sound-deadening material with Mylar, two drum companies have been able to produce practice drums which have the feel of a drumhead without the noise. Fips Drum Co., Inc., produces a complete practice drum set. Remo, Inc., offers snare and tom-tom practice pads mounted on wooden standards.

Readers' Service Item 48

☐ Hitemp FX magnet wire employs a cross-linked polymer for high temperature insulation and abrasion resistance. According to Hitemp Wires Co., only a single thickness of insulation is required to permit operating continuously in excess of 260° C.

Readers' Service Item 49

☐ Polystyrene foam is being used by Falls Bait Co. to package its Fish'n Fool lures. Arlite extruded film, made of Koppers Dylite expandable polystyrene, is a product of Applied Research and Development Corp., which also vacuum forms the packs. Arlite is available in a variety of colors and thicknesses of 7-15 mils.

Readers' Service Item 50

How SANTICIZER® 160 speeds processing and cuts costs of nonstaining PVC film and sheeting

PERFORMANCE: No other plasticizer can make film, sheeting, and floor covering so *STAIN-SAFE*—virtually impervious to asphalt, tar, grease, mustard, catsup, coffee, and other stainmakers. SANTICIZER 160 (butyl benzyl phthalate) also imparts toughness, high gloss, *and outstanding tear strength and dimensional stability.*

PROCESSING: Quick-fusing SANTICIZER 160 speeds Banbury mixing, milling, and calendering—*at lower processing temperatures.*

ECONOMY: SANTICIZER 160 is one of the lowest-priced primary plasticizers for vinyls. With its high tolerance for fillers and its high compatibility—*150 PHR for poly(vinyl chloride), 75 PHR for poly(vinyl acetate)*—it offers compounders savings on material, savings on formulation.

"TAILORED" BLENDS: In large-volume applications, when several plasticizers are used together in a fixed ratio for optimum performance, Monsanto can usually *custom blend* them to your specifications . . . to reduce your storage-facility requirements; eliminate mixing error or variation; and reduce inventory requirements, ordering costs, and production expense.

FACTS: Technical Bulletin PL-160 gives complete performance data—including specific details on how SANTICIZER 160 *also* can help you make:

- **lower-cure-temperature plastisols and organosols.**
- **high-gloss, water-resistant lacquers.**
- **economical vinyl chloride-vinyl acetate emulsions.**

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New Literature

For more information check Readers' Service Card (p. 69)

"Designing with Die Stamped Circuits." Bulletin No. D1. Dytronics, Inc. 12 pages. Features of die stamped circuits (made by die cutting the conductor pattern from copper foil coated on one side with a thermoresponsive adhesive and simultaneously bonding it to the base material) are compared with those of copper-clad laminate circuits. Design and fabrication information concludes the brochure.

Readers' Service Item 61

"Screen Process Equipment Catalog." American Screen Process Equipment Co. Over 1,000 pieces of equipment for automatic production on work of any shape, size, and material.

Readers' Service Item 62

"Dapon Diallyl Phthalate Resin for Molding Materials." Food Machinery & Chemical Corp. 26 pages. Properties, uses, and molding requirements of compounds based on diallyl phthalate resins, noted for dimensional stability, insulation resistance, and retention of electrical properties in severe environments.

Readers' Service Item 63

"Tested Performance of Vibra Screw Feeders on Various Materials." Vibra Screw Feeders, Inc. 8 pages. Performance of screw feeding equipment for 456 dry materials is tabulated. The following information is provided: material, density, screw size, maximum rate, per cent accuracy, and source.

Readers' Service Item 64

"How to Work with Plexiglas." Cadillac Plastic & Chemical Co. 20 pages. Cutting and machining, finishing, and joining Plexiglas is covered in detail. Excellent line drawings enhance the textual directions.

Readers' Service Item 65

"Machines for High Production Product Finishing." Conforming Matrix Corp. 10 pages. Nine finishing machines are illustrated and described. Included are spray painting machines, spindle painting machines, and mask washers.

Readers' Service Item 66

"Independent Laboratory News." Plastics Pacific Chemical Co. 2 pages. News of research and developments in plastics are featured in this periodical bulletin.

Readers' Service Item 67

"Stabilizer Handbook." Ferro Chemical Division, Ferro Corp. 40 pages. Provides complete data on stabilizing all forms of vinyls, including rigid and flexible, plastisols and organosols, expanded vinyls, homogenous tile, and asbestos tile. Another section suggests techniques for overcoming special problems such as water fogging or light stability, and a third covers standard quality control performance tests.

Readers' Service Item 68

"Screw Conveyors." Bulletin 83 A. Sprout, Waldron & Co., Inc. 8 pages. Specifications, illustrations, and cross section drawings of standard and special screw conveyors, conveyor boxes and covers, hangers, box ends, discharge openings, and couplings.

Readers' Service Item 69

"Technical Data Book." Holland Color and Chemical Co. General discussion of pigments and their characteristics. Covers flushed colors for printing inks, organic and inorganic colors for latex paints, and organic types for water flexographic inks.

Readers' Service Item 70

"Robinson Knife Cutters." Bulletin K-460-A. Young Machinery Co., Inc. 6 pages. Catalog of rotary knife cutters features photographs, cutaway drawings, and specifications. Several models and sizes can be supplied.

Readers' Service Item 71

"Facts on Testing." No. 5901. Thwing-Albert Instrument Co. 4 pages. This bulletin describes such testing equipment accessories as grips, cutters, calibrators, and impact and toughness attachments.

Readers' Service Item 72

"Injection Molding Quality Control." Phillips Chemical Co. 6 pages. Discusses effects of molding variables on toughness of high density polyethylenes and ethylene copolymers. Includes mold temperature, degree of mold packing, stock temperature, stock temperature uniformity, and injection speed; and summarizes optimum procedure.

Readers' Service Item 73

"A Report on the Status of the FDA Food Additives Amendment." Solar Services Research, Division of Solar Chemical Corp. 6 pages. A simplified explanation of the food additives amendment as it affects manufacturers and users of polystyrene.

Readers' Service Item 74

"Operating and Maintenance Instructions for Kamlar Welding Equipment for Plastics." Manual 60-2. Kamlar Products Co. 4 pages. Includes general description, installation, and operation (tacking, hand welding, and high speed welding). Equipment can be used with polyethylene, polypropylene, rigid and plasticized PVC, plasticized tank linings, etc.

Readers' Service Item 75

"Fabrication Data of Extruded Acrylic Sheets." Bulletin EX-101. Cadillac Plastic & Chemical Co. 12 pages. Information on handling, machining, forming, cementing, and annealing extruded acrylic sheets. Includes table of properties and light transmission charts.

Readers' Service Item 76

"Fiberglass Reinforced Plastics." Catalog C. Allied Resin Products Corp. 32 pages. Catalogs resins, reinforcements, and releases used in laminating and casting. Features technical data and directions for contact and spray-up molding. Outlines properties and handling procedures for polyester, epoxy, and foam-in-place resins.

Readers' Service Item 77

"Packaging—Last Step in Manufacture, First Step in Sales." Eastman Chemical Products, Inc. 20 pages. This profusely illustrated brochure discusses the how's and why's of packaging with cellulosics and polyolefins. The contents includes flexible film, coatings and laminations, bubbles and blisters, containers and closures, skin packages, and jars and bottles. Much information on applications and procedures.

Readers' Service Item 78

"Bonding Reinforced Teflon." TSB #121 (Revised). Rogers Corp. 3 pages. Tabulates adhesives and methods for bonding Teflon to itself and to metals.

Readers' Service Item 79

"Flexible Urethane Foam — Genetron Auxiliary Blowing Agents." General Chemical Division, Allied Chemical Corp. 8 pages. Genetron 11 and 113, halogenated hydrocarbons, can be used as supplementary blowing agents for flexible urethanes. The properties of these materials and their effects on foams are explained. Additional data on shipping, handling, etc., and several photographs of applications, are also supplied.

Readers' Service Item 80

"Glas*cushion." Bulletin TD-102. Fibrous Glass Products, Inc. 4 pages. This resilient material, fine glass fibers bonded with resin, is useful for packaging and dunnage. The bulletin shows some applications, lists specifications, and describes some cheaper commercial grades.

Readers' Service Item 81

NOW...

CONTROLLED F-L-E-X-I-B-I-L-I-T-Y

...with 2 New RCI EPOTUF Epoxy Hardeners

● You can control the degree of hardness or flexibility of your cured epoxy systems—when you use RCI EPOTUF Hardeners 2611 and 2613.

By blending the two, in conjunction with an epoxy resin, a formulator can easily and dependably produce systems that will result in hard, flexible or resilient products.

Each of the hardeners may be used individually . . . both are for room-temperature curing of epoxy resins.

EPOTUF Hardener 2611 is recommended in a simple 1:2 ratio with epoxy resins. It hardens the epoxy in 10 minutes to a hard, yet resilient, blush-free plastic. Because of its low viscosity, it handles easily and can be highly filled.

EPOTUF Hardener 2613 is generally used in a convenient 1:1 ratio with the epoxy resins. It cures rapidly with an unusually low exotherm. The flexible, blush-free system it provides has up to 100% elongation in a cured epoxy with total recovery.

Tensile strength of these systems will range from 2,000 psi to 14,000 psi.

Perhaps the controlled flexibility possible with these versatile new EPOTUF Hardeners can improve your epoxy systems. Write to RCI for complete technical information.

RCI *Creative Chemistry . . . Your Partner in Progress*

REICHHOLD

Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol • Hydrochloric Acid • Formaldehyde • Phthalic Anhydride • Maleic Anhydride
Ortho-Phenylphenol • Sodium Sulfite • Pentaerythritol • Pentachlorophenol • Sodium Pentachlorophenate • Sulfuric Acid • Methanol

REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N.Y.

$5 billion

That's the plastics market forecast for 1961. It's a lot of money and the people attending the Ninth National Plastics Exposition, June 5-9 at the New York City Coliseum will be responsible for spending most of it.

This is a big responsibility. We want to help our readers organize their time to get the most out of the exhibits. For this reason our engineering editor has collaborated with the editor of Sales Meetings (a sister publication) in preparing a unique article — "How to get the most out of the 9th National Plastics Exposition." This article will give tips and advise on planning their time in hunting for ideas for new applications, improved processing techniques, and better engineered products.

To get the attention you deserve at the industry's biggest show schedule *now* an ad in Plastics Technology's special May issue on the Exposition to focus attention on your own display.

Other special sections guarantee an unusual amount of readership both before, during and after the show. Among the planned editorial features:

- A carefully compiled list of exhibit features worth special attention.
- Classified list of materials and equipment.
- List of exhibitors.
- Floor plans of the exhibit areas.

Be sure you get the most out of it, too. Reserve space *now* in Plastics Technology's special Exposition issue.
Closing Date: May 1.

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Book Reviews

"Marine Design Manual for Fiberglass Reinforced Plastics." Gibbs & Cox, Inc. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N.Y. Cloth, 8¾ by 11¼ inches, 376 pages. $15.00.

This design manual was prepared by the firm of Gibbs & Cox, Inc., naval architects and marine engineers, under the sponsorship of Owens-Corning Fiberglas Corp. While it is primarily concerned with designing and fabricating boats for high structural performance and maximum durability, the manual will be almost as helpful for those concerned with the use of reinforced plastics in aircraft, automotive, and architecture applications.

Boat hull design, design details, materials and molding methods, engineering properties of laminates, and design of laminates are the major topical headings. Detailed design examples and illustrations of construction techniques carry the reader through the development of boat structures. Step-by-step manufacture of a rowboat, a day sailor, a high speed outboard, a 30-foot auxiliary sloop, and a 30-foot power cruiser is graphically outlined.

The manual was compiled from results of production by known fabricators. Tables provide all information on properties of different laminates, effects of different molding procedures, variations due to changes in type or quantity of glass content, etc. Inasmuch as these tables are compiled from what are considered representative products, they can be used as reference. The reader can compare the results of his own fabrication with those listed as desirable, and by following the text, can adjust his procedure for optimum results.

Great detail is one of the main features of the volume. For example, nine methods for joining the hull to the deck are described.

This book is undoubtedly a must for anyone concerned with the structural applications of reinforced plastics. However, since much is yet to be learned about the variability of laminates, even those produced by the same fabricator with the same raw materials, it can serve only as an excellent guide. The authors themselves warn in an appendix that this study, like other statistical studies, cannot be extended heedlessly. While there is a great deal of significant and valuable data in it, in some cases the book may serve merely to provide a general outline of work.

Certainly, to many who are accustomed to working with wood or metal, such a guide to reinforced plastics is necessary. In the former case, the material exists in its final state when it arrives at the boat manufacturer's plant; in the latter, the boat manufacturer must start with raw materials which do not assume final chemical or physical state until after processing. If this manual is used correctly, it should permit the fabricator to produce repeatable quality products. By providing data on the variables, it helps to make this goal possible.

"International Symposium on Plastics Testing and Standardization." ASTM Special Technical Publication No. 247. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Cloth, 6 by 9¼ inches, 272 pages.

Papers in this book were presented at a symposium sponsored by ASTM in October, 1958, in Philadelphia. The symposium covers four topics. "How National Standards Are Achieved" presents the views of 12 nations. Five papers are included under the topic "Engineering Properties of Plastics." The final sections, "Thermal Properties of Plastics" and "Molecular Characterization," conclude the volume with four papers each.

Most of the papers are concerned with nomenclature and test methods, equipment, and results. Shear test specimen shapes, flow testers, Vicat softening point, use of infrared spectroscopy and X-ray diffraction and scattering for study of polymer structure, and transition phenomena in impact strength study are some of the topics.

"Runnerless Molding." Ernest P. Moslo. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y. Cloth, 5¼ by 7½ inches, 162 pages. $4.95.

By runnerless molding, the author means the injection molding of thermoplastics without a conventional sprue and runner system. In other words, he discusses automatic injection molding, in which the finished part or parts are ejected without waste or flash which must be manually removed.

Beginning with the first automatic injection molding machines, the author progresses to the current valve gating and sequential impact molding. He discusses the process and equipment theoretically, without going into detailed design specifications.

Mr. Moslo covers the topic of nozzles quite thoroughly. Clear line drawings illustrate almost every type of nozzle practical, and each drawing is explained in the text. The minute differences in nozzle construction, he points out, can make a large difference in the success of the molding process.

Single cavity molds for thin wall containers and multiple cavity molds for many parts and products are depicted. Such problems as tonnage, venting, and ejection are briefly covered. Manifold and multiple runner arrangements for use with multiple cavity machines are graphically explained. Finally, Mr. Moslo goes into valve gating and sequential impact molding, two recent developments in the injection molding industry. In valve gating, conventional gates are replaced by valves. One of the advantages of valves is that the cavity openings are larger; thus, the mold can be kept in operation more simply. Further, cycles can be shorter. How a mold for valve gating differs in design from one with conventional gating comprises one chapter. Sequential impact molding, which comprises another chapter, is similar to precompressed molding with valve gating. A third recent development is the use of an insulated runner system. Designed for use with linear polyethylene, this system employs a standard three-gate mold.

Like most of the other volumes in Reinhold's Plastics Applications Series, this one covers its field adequately. It is introductory in that it does not provide specific engineering data which a mold designer or maker would require. At the same time, it is not too elementary for many who already have some knowledge about injection molding.

"An Introduction to Plastics." *Rubber and Plastics Age,* Gaywood House, Great Peter St., London S.W.1, England. Cloth, 8½ by 11 inches, 61 pages, 20/—($2.80).

This book consists of 29 articles reprinted from "Rubber and Plastics Age," June 1959 Export Number. The articles are organized under three categories: polymers and chemicals, processing and equipment, and applications.

Since the articles are only two pages long, there is no deep discussion of any one topic. Ephasis even in the sections on materials and equipment is on applications. If this were to be used as an introductory book on plastics, it would have to serve as a supplement to a more comprehensive report.

"Chemical Statistics Handbook." Fifth Edition. Manufacturing Chemists' Association, Inc. 1825 Connecticut Ave., N.W., Washington 9, D. C. Paper, 8½ by 11 inches. 521 pages. $3.00.

This publication, a continuation of a series that began in 1940, includes all available statistics from official sources for the chemical and allied product industries for the years 1954-1958. Tables list production and sales of thousands of chemicals. The contents is divided into sections on basic inorganic chemicals, sulfuric acid, chemical nitrogen, tars and tar crudes, synthetic organic chemicals, coal-tar dyes, plastics, synthetic rubber, industrial alcohol, fats and oils, naval stores, agricultural chemicals, and metals and minerals.

Under the section of employment and wage statistics are presented: average hourly and weekly earnings, average hours worked per week, estimated number of wage earners, labor turnover, and work stoppages. Tables of wholesale price indexes, financial and tax data, and imports and exports of chemicals follow. The publication concludes with chemical and mineral statistics from Canada.

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☐ **5. HOBBS DC FIELD CONTROL WINDER — WITHOUT DC MACHINE DRIVE.** For situations where synchronization is not necessary. Except for absence of synchronization, winder operates as above. An independent adjustable DC supply is provided for the automatic field control.

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Article Abstracts

Materials

"Properties of High Modulus Reinforced Plastics," G. P. Peterson, SPE J., 17, 1, 57 (Jan. 1961).

Data are given to show that glass filament containing berylium oxide increases modulus.

"The Measurement of Polyethylene Degradation by ZST Test," T. H. Meltzer and J. J. Muldrew, SPE J., 17, 1, 77 (Jan. 1961).

Use of the Zero Strength Time to measure degradation is described.

"Relations Between Physical Properties and Molecular Structure of Polyethylenes," N. H. Shearer, Jr., J. E. Guillet, and H. W. Coover, Jr., SPE J., 17, 1, 83 (Jan. 1961).

A useful series of curves are presented for determining these relations.

"Effect of Plasticizers on Plastisol Fusion," P. R. Graham and J. R. Darby, SPE J., 17, 1, 91 (Jan. 1961).

Microscopic measurement of the clear point of unfilled plastisols is shown to be a good method of demonstrating the fusion-promoting power of various plasticizers.

"New Foam Materials Based on Polyvinyl Formal," R. Braun, KUNSTSTOFFE, 50, 12, 729 (Dec. 1960).

Polyvinyl formal is the formaldehyde-acetal of polyvinyl alcohol, which is produced by saponifying polyvinyl acetate. During partial saponification, polyvinyl alcohol containing ester groups are produced which are further saponified during acetalization so that there will be free alcohol and ester groups present in the macromolecule. Foams based on this polyvinyl formal have sponge-like characteristics that are superior to natural sponge.

"Mineral Pigments for Coloring Plastics," A. Rossini, MATERIE PLASTICHE, 26, 10, 943 (Oct. 1960).

A discussion of the migration, fastness to light and heat of mineral pigments in plastics, and the reactivity of the pigments themselves is followed by brief reviews of the factors important for the selection of the most suitable pigments for each of the principal types of plastics. Tables present the chief properties of the pigments. (In Italian.)

"Rheological Characteristics of PVC Plastisols in Certain Applications," C. Corso, MATERIE PLASTICHE, 26, 10, 957 (Oct. 1960).

The author briefly defines the rheological functions: viscosity, thixotropy, yield point, and dilatency, before reviewing rheological characteristics of plastisols for use in coating, dipping, slush molding, rotation molding, spraying. (In Italian.)

"Improving Adhesion of Bonding Agents by Addition of Isocyanates," K. H. Kussner, PLASTE U. KAUTSCHUK 7, 8, 389 (Aug. 1960).

Triisocyanates, sold under the name of Utazian D in East Germany, have given good results in tests to improve adhesion of locally-produced glues for bonding Buna vulcanizates to iron and wood; PVC to metals; polyamides to metals, wood, glass, and glazed tile; and polyamide fabric to rubber for use in tire and tarpaulin manufacture. (In German.)

"Viscosity Measurements on Solutions in Relation to Pressure and Molecular Weight of the Solute," W. Werner, PLASTE U. KAUTSCHUK 7, 8, 391 (Aug. 1960).

Unfractionated polystyrene and polystyrene fractions of different molecular weight were tested in a falling ball, Hoppler-type viscosimeter in a pressure range of 1 to 5,000 kp.cm^{-2} at 30° C. The relations of viscosity to molecular weight are graphically represented. (In German.)

"Gluing Foamed Materials," W. Schneider, PLASTVERARBEITER, 11, 8, 364 (Aug. 1960).

Methods of foaming plastics and gluing them are reviewed and a description is given of the various types of foamed plastics, their special requirements as to adhesives, and the manner of applying the latter. (In German.)

"Production and Transformation of Polyethylene Film," E. Springler, PLASTVERARBEITER, 11, 8, 366 (Aug. 1960).

This is a report on the production methods, transformation, consumption and prospects of polyethylene film in the United States. (In German.)

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in May. The last listing appeared in the January issue.

"Polymeric Melts," A. B. Metzner, E. L. Carley, and I. K. Park, MODERN PLASTICS, 37, 11, 133 (July 1960).

A report on the steady-state flow properties of molten polymers.

"Stabilization of Mixed Polyamides," M. M. Epstein and C. W. Hamilton, MODERN PLASTICS, 33, 11, 142 (July 1960).

An A. C. S. Plastics Division paper presented in 1959.

"The Mechanico-Chemical Degradation of Plastomers," R. J. Ceresa, TRANS. PLASTICS INST., 28, No. 76, pp. 178 (Aug. 1960).

A historical survey of methods by which high polymers have been degraded mechanically, with special mention of evidence for free-radical processes.

"Testing of Plastics Pipe," F. W. R. Wijbrans, PLASTICA, 13, 1, 18 (Jan. 1960).

Tests and research of burst strength of polyethylene and PVC pipe. (In Dutch).

"Weathering of High Polymers," H. J. M. Langshaw, PLASTICS, 25, 267, 40 (Jan. 1960).

Deterioration of high polymers in normal service is outlined. Surface phenomena are better weather damage assessors than bulk physical or mechanical properties.

"Cross-Linking of PVC by Ionizing Radiation," S. H. Pinner, PLASTICS, 25, 267, 35 (Jan. 1960).

Structure and properties of PVC cross-linked by irradiation in the presence of diallyl and triallyl esters.

"Statistical Methods in the Research and Application of Bonding Techniques," M. Lidarik, PLASTE U. KAUTSCHUK, 7, 2, 55 (Feb. 1960).

Investigation and application of synthetic adhesive bonding of metals. (In German).

"Testing of PVC-Coated Fabric," W. K. Dalton, PLASTICS, 25, 268, 71 (Feb. 1960).

Tests to determine quality of PVC-coated fabrics include visual and manual tests, weights, breaking load, tear strength, burst strength, flex resistance, effect of heat aging, surface conditions, etc.

"Hydrocarbon Resins," C. J. M. Brouwer, PLASTICA, 13, 4, 266 (April 1960).

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indene resins, methods of producing petroleum resins, and applications of both types of materials. (In Dutch).

Equipment

"The Use of Strain Gages in Studying Mechanical Properties of Plastics," P. Depalle and F. Ecochard, IND. PLASTIQUES MOD., 12, 9, 37 (Nov. 1960).

Strain gages are either applied directly to the piece being tested when surface deformations are measured, or to a special test "captor" (metallic element working in the elastic field) which takes up stresses or mechanical forces. The modern dynamometer with strain gages is an example of the latter use, and its advantages are described. It is shown how devices with special "captors" may be designed for studying mechanical properties of plastics, such as relaxation, modulus of elasticity, hardness, coefficient of friction, etc. (In French.)

"Present Status and Trends in the Development of Presses for Producing Laminated Panels," F. Lange, PLASTE U. KAUTSCHUK, 7, 9, 443 (Sept. 1960).

General considerations of the manufacture and use of laminated fabric and paper panels precede a description of a 5,000-ton, 12-platen press designed by an East German firm for panels 1,300 x 2,850 mm. (about 51 by 112 inches). (In German.)

"Zis-G-104-59 Welding Equipment for Making Bags of Thin Polyethylene Film," G. Hartung, PLASTE U. KAUTSCHUK, 7, 9, 469 (Sept. 1960).

Fusion-welding equipment is described which was developed by the East German Central Welding Institute, Halle, for making and sealing bags for packaging, two seams being welded in one operation. (In German.)

"The Performance of Single Screw Extruders in the Processing of Polyolefins and PVC—Part I," H. O. Schiedrum and H. Dominghaus, PLASTICS (LONDON), 26, 280, 83 (Feb. 1961).

The first part of an article on single-screw extruders and their operation.

"The Casting of Molds for Injection Molding and Deep Drawing Using Zinc Alloys," KUNSTSTOFFE, 50, 12, 723 (Dec. 1960).

Mold costs may be reduced by reducing the amount of machining in making the mold. Experiments are carried out in casting such molds from high-grade zinc alloys which are superior in ease of casting. These alloys can be made by chill casting and sand casting methods, giving good surfaces. When using this type of mold for processing thermoplastics, the molder should allow for alloy properties that are different from those of steel.

(*Continued on page 66*)

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Patent Digest

Materials

Phenyl Diester of Dihydroxy Terephthalic Acids and Vinylidene Chloride Polymers Stabilized Therewith. No. 2,952,661. D. A. Gordon and C. W. Hinman, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

Highly Cross-Linked Non-Flammable Polyurethane Foams and Preparation of Same. No. 2,953,533. A. Khawam, E. Orange, N. J. (to Allied Chemical Corp.).

Aqueous Composition of Melamine-Formaldehyde Resin, and Cellulosic Body Impregnated Therewith. No. 2,953,534. C. S. Schneider, 143 Nixon Ave., Staten Island, N. Y.

Vinyl Halide Polymer Composition. No. 2,953,537. W. K. McBrien, Painesville, O. (to Diamond Alkali Co., Cleveland, O.).

Composition Comprising a Thermoplastic Resin and Keto-Acid Ester Plasticizer. No. 2,953,540. E. J. De Witt, Akron, and S. J. Averill, Boston, O. (to B. F. Goodrich Co., New York, N. Y.).

Polyurethane Foams Coated with a Polyurethane Elastomer, No. 2,955,056. R. E. Knox, Brandywine Hundred, Del. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Stabilized Vinyl Chloride Resin Compositions. No. 2,954,362. J. E. Wilson, Highland Park, N. J. (to Union Carbide Corp.).

Spray Application of Foamable Polyurethane Materials. No. 2,955,058. S. R. Foster, Wilmington, De. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Process for Dyeing Polyethylene Terephthalates. No. 2,955,901. W. Kruckenberg, Leverkusen-Bayerwerk, Germany (to Farbenfabriken Bayer AG., Leverkusen, Germany).

Process for Treating Shaped Articles Prepared from Synthetic Linear Polyesters. No. 2,955,954. R. J. Collins, Kinston, N. C. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Protecting Polystyrene. No. 2,955,955. J. B. Orr, Great Barrington, Mass. (to Sheffield Plastics, Inc., Sheffield, Mass.).

Process of Coating Polyethylene Terephthalate Substrate with a Polyurethane and Resultant Articles. No. 2,955,961. C. R. Koller, Newark, Del. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Method of Forming Padded Articles. No. 2,955,972. G. E. Wintermute and H. W. Carmichael, Columbus, Ind. (to Arvin Industries, Inc., Columbus, Ind.).

Highly Cross-Linked Non-Flammable Polyurethane Compositions and Preparation of Same. No. 2,956,031. A. Khawam, E. Orange, N. J. (to Allied Chemical Corp.).

Fire Resistant Organosiloxane Elastomer Foams and Method of Preparing Same. No. 2,956,032. R. L. Joyce, Midland, Mich. (to Dow Corning Corp., Midland, Mich.).

Block-Resisting Polyethylene Film Compositions. No. 2,956,093. H. W. Mock, Plainfield, N. J. (to Union Carbide Corp.).

Composition Containing Vinyl Halide Resin and Chlorosulfontated Polyethylene. No. 2,956,980. O. L. Law, Akron, O. (to Goodyear Tire & Rubber Co., Akron, O.).

Stabilization of Polyethylene. No. 2,956,982. M. A. McCall and H. W. Coover, Jr., Kingsport, Tenn. (to Eastman Kodak Co., Rochester, N. Y.).

Process for the Production of Colorless Polyolefines by the Low Pressure Process. No. 2,956,983. E. Rindtorff, Recklinghausen, K. Schmitt, Herne, and G. Keller, Wanne-Eickel, Germany (to Bergwerksgesellschaft Hibernia AG., Herne, Germany).

Furfural - Aldehyde Polycondensation Products with Unsaturated Hydrocarbons and Process of Making. No. 2,956,040. K. Dietz, Kronberg (Taunus), and G. M. R. Lorentz, Frankfurt am Main, Germany (to Farbwerke Hoechst AG., vormals Meister Lucius & Bruning, Frankfurt am Main, Germany).

Acryloxymethylsilicon Polymers. No. 2,956,044. R. L. Merker, Pittsburgh, Pa. (to Dow Corning Corp., Midland, Mich.).

Polymerization of Acrylic Acid Salts and the Like. No. 2,956,046. F. J. Glavis, Elkins Park, and D. G. Downing, Upper Darby, Pa., and H. M. Grotta, Columbus, O. (to Rohm & Haas Co., Philadelphia, Pa.).

Manufacture of Copolymers of Trifluorochloroethylene and Vinylidene Fluoride. No. 2,956,048. A. N. Bolstad, Maplewood, and F. H. Honn, Westfield, N. J. (to Minnesota Mining and Mfg. Co., St. Paul, Minn.).

Thermoplastic Laminate for Use in Lining Storage Tanks. No. 2,956,915. I. Korn, Great Neck, and J. S. Kaye, Brooklyn, N. Y.; V. C. Pierce, Yardville, and W. Walworth, Groveville, N. J., and J. Huscher, Philadelphia, Pa. (to Kaye-Tex Mfg. Co., New York, N. Y.).

Copolymers of Polyesters and Oxygen-Containing Vinyl Compounds. No. 2,941,976. J. Philipson, Temple City, Calif. (to Aerojet-General Corp., Cincinnati, O.).

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Prices, 25c each.
—The Editor

Equipment

Method and Apparatus for Collapsing Thermoplastic Tubing. No. 2,955,318. S. O. Cook, Somerville, and W. A. Miller, N. Caldwell, N. J. (to Union Carbide Corp.).

Method and Apparatus for Manufacturing Synthetic Nets. No. 2,957,200 H. Pufahl, 1568 Miriam Ct., Elmont, N. Y., and J. Pufahl, 81 Gerard Ave., New Hyde Park, N. Y.

Method and Apparatus for Continuously Curing Plastic Material. No. 2,958,096. D. G. Hunt and L. T. Ream, Akron, O. (to B. F. Goodrich Co., New York, N. Y.).

Extrusion Die for Plastic Extruders. No. 2,958,099. D. S. Chisholm and H. R. Bylsma, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

System for the Continuous Calendering of Plastics such as Synthetic Resins. No. 2,959,811. I. Curletti, Milan, Italy (to Montecatini-Societa Generale per l'Industria Mineraria e Chimica).

Apparatus for Forming Foamed Plastic Objects. No. 2,960,720. G. E. Jodell, Toorak, Victoria, Australia (to Aktiebolaget Electrolux, Stockholm, Sweden).

Extrusion Die for Two-Ply Seamless Plastic Tubing. No. 2,957,201. C. M. Fields and H. K. Mallett, Zanesville, O. (to Continental Can Co., Inc., New York, N. Y.).

Multiwall Containers. No. 2,959,812. K. R. Allen, Taylorville, Ill. (to Plax Corp., Bloomfield, Conn.).

Rotational Casting Apparatus. No. 2,957,202. P. Rekettye, Akron, O. (to Sun Rubber Co., Barberton, O.).

Process and Apparatus for Making Plastics. No. 2,957,203. W. W. Marshall III, St. Louis, Mo. (to Mobay Chemical Co., St. Louis, Mo).

Shut-Off Nozzle for Injection Molding of Thermoplastic Materials. No. 2,940,123. H. Beck, Ludwigshafen (Rhine), Germany, and J. Wahlandt, Trelleborg, Sweden (to Badische Anilin- & Soda-Fabrik AG, Ludwigshafen (Rhine), Germany).

Process of Forming Screw Threads on Cold Rod of Rigid Thermoplastic Material. No. 2,957,205. A. Barber and R. Hardy, New Bedford, and H. Rowbotham, S. Dartmouth, Mass. (to Black & Webster, Inc., Watertown, Mass.).

Apparatus for Continuous Calendering of Resinous Materials, Particularly Synthetic Thermosetting Resins. No. 2,958,-094. I. Curletti, Milan, Italy (to Montecatini, Societa Generale per l'Industria Mineraria e Chimica).

Machine for Making Molded Bodies. No. 2,958,095. E. H. Ahlefeld, Jr., Woodbridge, and D. F. Spengler, Milford, Conn. (to Molded Rubber Products Corp., Milford, Conn.)

Apparatus for Forming Hollow Plastic Articles. No. 2,943,348. G. V. Mumford, and O. B. Sherman, Toledo, O. (to Owens-Illinois Glass Co.).

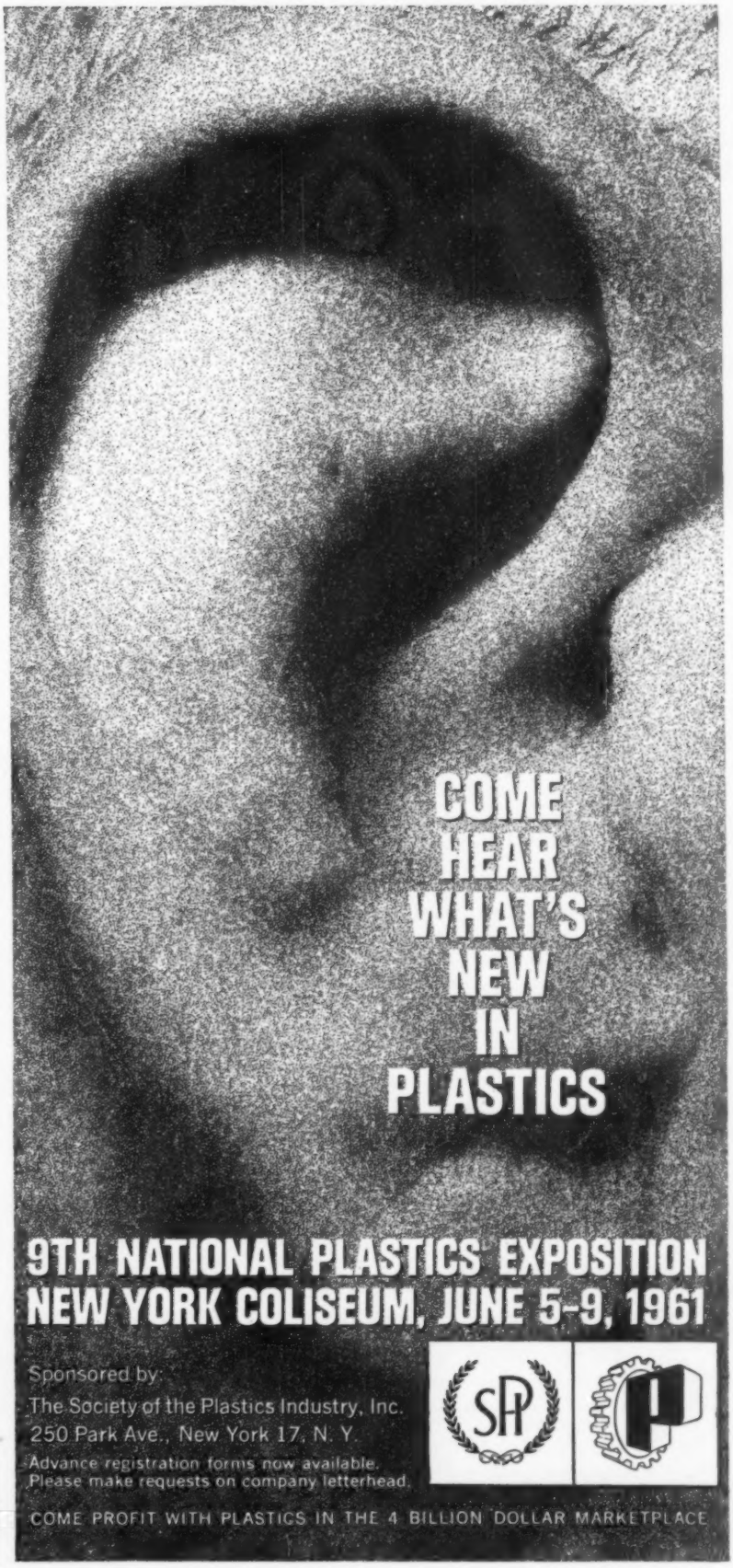
Methods of and Apparatus for Extruding Plastic Materials. No. 2,943,351. A. N. Gray, Edgewood, Md. (to Western Electric Co., Inc., New York, N. Y.).

Plastic Material Extrusion Head. No. 2,943,352. J. W. Van Riper, 208 Beechwood Rd., Ridgewood, N. J.

Molding Presses. No. 2,943,353. W. S. Fraula, Ridgewood, and W. J. Olson, Packanack Lake, N. J. (to American Brake Shoe Co., New York, N. Y.).

Apparatus and Method for Molding Plastic Material. No. 2,943,354. H. Z. Gora, Stratford, Conn. (to Eagle-Picher Co., Cincinnati, O.).

Automatic Web Indexing and Cut-Off Apparatus for Plastic Blister Forming Machine. No. 2,960,722. P. Freeman, 1391 E. 33rd St., Cleveland 14, O.



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CALENDAR of COMING EVENTS

April 20
SPE Western New England Section RETEC. Plastics—A New Dimension in Buildings. Springfield Museum of Art, Springfield, Mass.

April 27-28
SPI Eighteenth Annual Western Section Conference. Hotel del Coronado, Coronado, Calif.

May 9
SPE Detroit Section RETEC. Plastics in the Automotive Industry. Detroit, Mich.

May 16-18
Building Research Institute 1961 Spring Conferences. Shoreham Hotel, Washington, D. C.

May 22
ASME Design Engineering Conference and Show. Cobo Hall, Detroit, Mich.

June 5-9
SPI National Plastics Conference. Commodore Hotel, New York, N. Y.

June 5-9
SPI Ninth National Plastics Exposition. Coliseum, New York, N. Y.

June 11-15
ASME Summer Annual Meeting. Statler Hilton, Detroit, Mich.

June 14
SPE Quebec Section RETEC. Plastics in Packaging. Montreal, Quebec, Canada.

June 15-16
Purdue University, SPI, and American Society of Tool and Mfg. Engineers. Annual Plastics for Tooling Seminar. Purdue University, Lafayette, Ind.

June 16-25
Europlastic 61. International Plastics Exhibition. Palais des Floralies, Ghent, Belgium.

June 19-20
Plastics Institute. Education and Training in the Plastics Industry. Institution of Electrical Engineers, Savoy Place, London W.C. 2, England.

June 21-July 1
International Plastics Exhibition and Convention. Grand, National, & Empire Hall, Olympia, London.

June 25-30
ASTM Annual Meeting. Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

July 3-7
Gordon Research Conferences. Polymers. Colby Junior College, New London, N. H.

July 17-21
Gordon Research Conferences. Elastomers. Colby Junior College, New London, N. H.

Abstracts of Important Articles (Cont'd.)

Applications

"Designing Thermoplastic Structural Components," W. D. Harris, W. W. Burlew, and Frederick McGarry, SPE J., 16, 11, 1231 (Nov. 1960).

Two methods are described for predicting load-carrying ability of thermoplastics.

"Adhesives for Poly (Vinyl Chloride) Shoes," R. J. Carey, SPE J., 16, 11, 1253 (Nov. 1960).

A brief discussion of adhesives for vinyl shoes.

"Plastics in Agriculture—From Seed to Food," C. E. Staff, INDIAN PLASTICS, p. 44, (April-May 1960).

A brief, non-technical review of agricultural uses for plastics.

"A New Technique for Reducing Cost in Plastic Laminate Parts," R. A. Anjesky, INSULATION, p. 45 (Aug. 1960).

An explanation of the Mold-fab method for making laminate parts.

General

"Half a Century of Plastics," H. Saechtling, KUNSTSTOFFE, 50, 12, 653 (Dec. 1960).

A survey of the progress made in the past 50 years. Every consideration shows that progress has been caused by constant development of materials and methods of processing.

"The Plastics Industry in the United States of America." H. Jenest. KUNSTSTOFFE, 50, 12, 705 (Dec. 1960).

This report from Arthur D. Little, Inc., shows numerous parallels with the German plastics industry.

"Competition between Steel and Synthetic Resins," M. di Falco, POLIPLASTI, 8, 41, 9 (July-Aug., 1960).

The growing use of plastics in fields traditionally belonging to metals, has led the author to examine the competition between the two classes of materials in order to throw some light on its significance for modern economy. In the present article he discusses the larger economic aspects involved; later he intends to deal with the cost and price factors. (In Italian.)

Domestic Production and Sales of Plastics and Resin Material, November and December, 1960

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of November and December, 1960. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

	November, 1960		December, 1960	
	Production	Sales	Production	Sales
Cellulose Plastics:				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,389,724	1,538,483	1,879,982	1,655,939
Sheets, 0.003 gage and over	1,891,955	1,872,042	2,002,516	1,645,458
All other sheets, rods, and tubes (including other cellulose plastics)	791,455	824,082	878,184	792,048
Molding and extrusion materials (including other cellulose plastics)	7,123,652	6,361,736	6,136,888	6,133,047
Nitrocellulose sheets, rods, and tubes	85,176	97,089	74,193	109,734
TOTAL	11,357,653	10,693,432	10,971,763	10,245,226
Phenolic and Other Tar-Acid Resins:				
Molding materials	15,435,240	13,350,269	15,035,342	12,537,132
Bonding and adhesive resins for—				
Laminating (except plywood)	5,337,054	3,413,939	5,602,411	3,011,138
Coated and bonded abrasives	1,189,975	981,857	1,048,864	814,439
Friction materials (brake linings, clutch facings, and similar materials)	985,612	740,545	812,781	781,522
Thermal insulation (fiber glass, rock wool)	3,859,762	3,823,885	3,309,664	3,226,314
Plywood	4,189,051	3,487,596	4,372,510	3,402,728
All other bonding and adhesives uses	5,741,855	5,417,499	5,979,988	5,283,414
Protective-coating resins unmodified and modified except by rosin	2,077,751	1,542,063	1,673,390	1,223,311
Resins for all other uses	3,307,784	2,784,122	3,161,158	3,101,594
TOTAL	42,164,084	35,541,775	40,996,108	33,381,592
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	2,450,515	2,286,189	2,605,959	2,119,330
Paper-treating and paper-coating resins	1,999,197	1,739,779	1,820,303	1,892,699
Bonding and adhesive resins for—				
Laminating	2,718,599	2,136,709	1,990,596	1,929,196
Plywood	7,553,303	7,057,068	6,505,727	5,907,801
All other bonding and adhesive uses	2,391,172	2,327,621	2,355,464	2,006,720
Protective-coating resins, straight and modified	2,935,116	1,764,342	2,505,774	1,894,156
Resins for all other uses, including molding	8,813,049	9,153,496	8,551,163	8,228,702
TOTAL	28,860,951	26,465,204	26,334,986	23,978,604
Styrene Resins:				
Molding and extrusion materials:				
Straight polystyrene	25,552,042	20,009,440	21,919,459	20,470,524
All other	29,131,017	24,073,992	30,430,197	25,723,049
Protective-coatings	6,327,834	5,019,536	5,776,742	4,891,931
Textile and paper treating and coating resins	6,083,281	4,838,120	6,002,113	4,640,365
All other uses	13,211,240	17,884,166	12,904,418	17,392,445
TOTAL	80,305,414	71,825,254	77,632,929	73,118,314
Vinyl and Vinyl Chloride Resins:				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		7,351,076		7,948,360
Sheeting (resin content)		10,830,050		8,638,079
Molding and extrusion (resin content)		25,458,939		22,064,858
Textile and paper treating and coating (resin content)		4,615,328		5,001,404
Flooring (resin content)		14,003,989		12,506,916
Protective coating (resin content)		2,872,945		2,321,762
All other uses (resin content)		9,784,208		6,823,163
All other vinyl resins for—				
Adhesives (resin content)		4,750,784		4,264,402
Protective coatings (resin content)		2,620,159		1,994,069
All other uses (resin content)		10,224,773		9,526,418
TOTAL	98,006,942	92,512,251	86,708,787	81,089,431
Coumarone-Indene and Petroleum Polymer Resins	17,916,411	17,606,739	16,515,852	15,213,064
Polyester Resins:				
For reinforced plastics	9,211,049	8,040,143	9,090,014	7,397,007
For all other uses	1,985,161	2,125,562	1,872,760	2,172,636
TOTAL	11,196,210	10,165,705	10,962,774	9,479,643
Polyethylene Resins:		37,062,652		31,169,898
For film and sheeting		14,009,800		13,889,219
Molding materials		13,296,141		10,619,610
Extrusion materials		46,377,422		44,682,498
TOTAL	114,135,458	110,746,015	119,674,860[1]	110,361,225[2]
Epoxy Resins:				
For protective coatings		1,539,343		1,556,208
For all other uses		2,282,408		1,751,428
TOTAL	4,281,576	3,821,751	4,790,851	3,307,636
Silicone Resins	545,422	349,263	316,451	373,541
Miscellaneous Synthetic Plastics and Resin Materials	25,622,333	21,384,314	24,303,696	20,422,765
GRAND TOTALS	434,392,454	401,111,703	418,609,057	370,971,041

[1] 15.7% produced by the low-pressure process.
[2] 13.9% produced by the low-pressure process.
SOURCE: United States Tariff Commission, Chemical Division.

Current Market Prices

This listing is as comprehensive and up-to-date as possible. The full listing will appear regularly, while intervening issues will carry a brief tabulation of price changes and additions.

Suppliers whose products do not appear are invited to submit their price data for inclusion in the published listing, as well as any price changes and additions promptly as they occur in order to assure maximum accuracy and value of the listing.

As can be seen, trade names or other company-originated names do not appear in the published tabulation. Products are grouped under their chemical names or chemical types. Any new products to be added to the list should also be so identified by the supplier firm. With the published listing, any questions on prices for specific products should be referred to us. We, in turn, can inform you of the suppliers whose product prices are included in our published listing and, similarly, refer these requests directly to the appropriate supplier(s).

Prices in general are f.o.b. works. Ranges indicates variations in grade, quality, quantities, and geographical locations of customers. No guarantee of these prices is made, and spot prices should be obtained from the individual suppliers.

Catalysts

Ammonium thiocyanate	lb.	$0.1725	$0.26
Peroxide, acetyl, 25% in DMP	lb.	1.75	4.00
Benzoyl, dry, 96%	lb.	.88	2.00
Wet, 50% paste in TCP	lb.	.89	2.25
In silicone fluid	lb.	2.75	4.25
In BBP	lb.	3.00	4.25
Caprylyl, liquid, 50% in mineral oil	lb.	4.45	5.00
In DOP	lb.	5.00	
Cyclohexanone, 45% paste in DBP	lb.	3.00	4.00
Powder, 85%, in DBP	lb.	2.00	3.00
p-Cyclobenzoyl, paste, 50%			
In mineral oil	lb.	4.25	5.00
In TCP	lb.	5.00	
2,4-Dichlorobenzoyl, 50%			
In silicone oil	lb.	4.25	5.00
40% in silicone oil	lb.	5.00	
Di-t-butyl	lb.	2.00	4.00
Other peroxides	lb.	2.05	5.00

Colorants

Black, std.	lb.	.90	4.10
Gel coats	lb.	.61	.86
Carbon black	lb.	.0575	.87
Paste	lb.	.65	.74
Bone blacks	lb.	.175	.2775
Iron oxide	lb.	.15	.23
Lampblack	lb.	.1225	.175
Masterbatch	lb.	.60	.63
Paste (for epoxies)	lb.	1.58	2.15
Paste dispersion	lb.	.85	1.90
Paste concentrate	lb.	.82	1.20
Pigment dispersion	lb.	.83	1.15
Colloidal dispersions	lb.	.66	1.45
Aqueous	lb.	.115	.395
Blue, std.	lb.	.90	2.75
Concentrate	lb.	.95	3.00
Masterbatch	lb.	.85	1.13
Pearl	lb.	1.38	
Metallic	lb.	.02	
Paste (for epoxies)	lb.	1.25	2.60
Paste dispersion	lb.	.85	2.40
Paste concentrate	lb.	.78	.80
Phosporescent	lb.	.24	
Brown, std.	lb.	.87	4.00
Copper tinsel	lb.	.10	
Gel coats	lb.	.59	1.04
Iron oxide	lb.	.15	.24
Metallic bronze	lb.	.02	
Paste (for epoxies)	lb.	1.18	1.47
Paste dispersions	lb.	.75	1.70
Paste concentrate	lb.	.65	2.30
Gold, metallic	lb.	.21	
Paste dispersions	lb.	1.40	1.60
Tinsels	lb.	.10	
Gray, gel coat	lb.	.59	.84
Paste (for epoxies)	lb.	1.40	
Paste dispersion	lb.	1.45	2.20
Green, std.	lb.	.90	3.25
Pearl	lb.	.10	
Concentrate	lb.	.95	3.00
Metallic	lb.	.21	
Phosphorescent	lb.	.24	
Masterbatch	lb.	1.20	1.23
Paste (for epoxies)	lb.	2.86	
Paste dispersions	lb.	.85	2.70
Paste concentrate	lb.	.80	2.15
Chromic oxide	lb.	.45	1.40
Orange, dry	lb.	.49	3.50
Gel coat	lb.	.75	1.05
Paste (for epoxies)	lb.	1.58	
Paste dispersion	lb.	.55	2.80
Paste concentrate	lb.	1.58	
Purple, pearl	lb.	.10	
Red, std.	lb.	$0.1425	$5.00
Cadium lithopone	lb.	1.90	2.86
Selenide	lb.	4.60	7.15
Concentrate	lb.	2.25	2.50
Iron oxide	lb.	.0475	.205
Metallic	lb.	.021	
Masterbatch	lb.	.75	.88
Paste (for epoxies)	lb.	2.35	3.77
Paste dispersions	lb.	.90	3.05
Paste concentrate	lb.	5.42	6.49
Venetian	lb.	.065	.1325
Silver, metallic	lb.	.0165	
Paste (for epoxies)	lb.	1.55	
Paste dispersion	lb.	.85	1.45
Paste concentrate	lb.	1.02	
Tinsels	lb.	.10	
Yellow, std.	lb.	.12	3.50
Cadium lithopone	lb.	1.21	1.29
Gel coat	lb.	.61	1.03
Masterbatch	lb.	.90	.93
Concentrate	lb.	1.00	2.50
Iron oxide	lb.	.1225	.1875
Paste (for epoxies)	lb.	2.15	2.55
Paste dispersions	lb.	.90	2.20
Paste concentrate	lb.	.65	2.87
White, std.	lb.	.54	4.00
Concentrate	lb.	.70	1.25
Gel coat	lb.	.59	.84
Masterbatch	lb.	.75	.80
Pearl	lb.	.10	
Paste (for epoxies)	lb.	1.02	
Paste dispersion	lb.	.70	2.00
Paste concentrate	lb.	.705	.725

Fillers

Aluminum silicate pigments	ton	21.50	65.00
Barytes	ton	60.00	123.00
Paste concentrate	lb.	.705	.725
Calcium carbonate, ppt.	ton	55.00	75.00
Std.	ton	14.00	35.00
China clay	ton	40.00	
Flours	ton	50.00	106.00
Flocks, cotton	lb.	.12	.30
Rayon	lb.	.50	1.25
Nylon	lb.	.35	2.75
Mica	lb.	.075	4.44
Silica	ton	25.00	48.50
Whiting	ton	8.75	13.25
Wollastonite	ton	29.00	47.50

Miscellaneous

Anti-Fog	gal.	8.69	16.95
Anti-Static	gal.	3.57	8.50
Purging cmpd. (for injection)	lb.	.40	
Wetting agent (for dry coloring)	gal.	2.50	3.20

Mold Release Agents

Silicone type: Cmpds.	lb.	4.70	5.20
Emulsions	lb.	1.09	1.65
Fluids	lb.	2.74	6.00
Solvent emulsions	lb.	.40	4.95
Stearates: Barium	lb.	.41	.46
Calcium	lb.	.39	.44
Magnesium	lb.	.42	.47
Zinc	lb.	.41	.48

Plasticizers

Adipate, Butyl Cellosolve	lb.	.45	.47
Didecyl	lb.	.265	
Dibutoxyethyl	lb.	.425	.46
Diisodecyl	lb.	.40	.44
Diisobutyl	lb.	$0.41	$0.44
Dioctyl	lb.	.40	.535
Diisooctyl	lb.	.40	.435
2-ethyl hexyl	lb.	.40	.44
Isooctylisodecyl	lb.	.40	.435
Isooctyl	lb.	.49	.535
n-Octyl decyl	lb.	.40	.44
Azelate, dioctyl	lb.	.445	.49
Epoxy, polymeric	lb.	.3225	.3525
Monomeric	lb.	.3475	.3775
Ester, Fatty Acid	lb.	.3525	.3775
Monomeric	lb.	.35	.60
Oleate, Butyl	lb.	.24	.42
Phosphate, Tributyl	lb.	.50	.535
Tricresyl	lb.	.325	.36
Phthalate, Butyl Cellosolve	lb.	.35	.385
Butyl octyl	lb.	.255	.30
Cyclohexyl	lb.	.265	.305
Isodecyl	lb.	.26	.30
Dibutyl	lb.	.285	.43
Dicapryl	lb.	.265	.445
Dicyclohexyl	lb.	.465	.495
Didecyl	lb.	.265	
Diisodecyl	lb.	.265	.45
Diisooctyl	lb.	.26	.445
Dioctyl	lb.	.265	.305
Isooctyldecyl	lb.	.27	.45
Polyester type	lb.	.385	.7125
Polymeric type	lb.	.39	.93
High-solvating	lb.	.37	.425
Ricinoleate type	lb.	.32	.35
Sebacate, Dibenzyl	lb.	.91	1.04
Dibutyl	lb.	.655	.745
Dioctyl	lb.	.5925	.6825
Soy Bean oil, epoxized	lb.	.3235	.4775
Stearate, Butyl	lb.	.2225	.3825
Epoxized octyl	lb.	.3475	.5325
Octyl epoxy	lb.	.3925	.4475
Tallate, Octyl epoxy	lb.	.3475	4.025

Resins, Molding, Casting & Coating

ABS type	lb.	.45	.56
Acrylic	lb.	.46	1.08
Alkyd	lb.	.1325	.137
Allyl (diallyl phthalate)	lb.	.95	3.20
Carbonate	lb.	1.30	2.25
Cellulosics:			
Cellulose acetate	lb.	.35	.68
Reprocessed	lb.	.25	.36
Cellulose acetate-butyrate	lb.	.40	.81
Reprocessed	lb.	.35	.45
Cellulose propionate	lb.	.40	.81
Ethyl cellulose	lb.	.67	
Reprocessed	lb.	.30	
Epoxy, liquid	lb.	.60	1.41
Solid	lb.	.51	1.31
Fluorocarbons	lb.	9.75	
Furane	lb.	.75	1.00
Liquid	lb.	.32	.44
Melamine coating solns.	lb.	.3275	.4375
Phenolic	lb.	.207	.7175
Coating solns.	lb.	.305	.3525
Polyamide	lb.	.98	1.85
Graphite-filled	lb.	1.40	1.83
Heat-stabilized	lb.	1.09	1.55
Molybdenum sulfide-filled	lb.	1.19	2.10
Polyester, powder	lb.	.26	.545
Coating	lb.	.0975	.1275
Polyethylene, low-density	lb.	.2375	.615
Medium-density	lb.	.2375	.6425
High-density	lb.	.275	1.29
Polypropylene	lb.	.42	.68
Reprocessed	lb.	.50	
Polystyrene	lb.	.18	1.34
Reprocessed	lb.	.15	.26
Polyurethane	lb.	1.30	7.50
Silicones, casting	lb.	7.50	11.40
Molding	lb.	2.40	3.55
Urea coating solns.	lb.	.205	.27
Vinyl, dispersion grade	lb.	.24	.325
Molding	lb.	.185	.66
Nitrile rubber blend	lb.	.45	.53
Reprocessed	lb.	.19	.22
Vinylidene	lb.	.205	.32
Latex	lb.	.45	.52

Solvents

Ketones: Acetate	lb.	.08	.22
Methyl isoamyl	lb.	.175	.315
Esters: Ethyl acetate	lb.	.125	.2675
Isopropyl acetate	lb.	.115	.255
n-Butyl acetate	lb.	.145	.285
Alcohols: Isobutyl	lb.	.13	.27
n-Butyl	lb.	.155	.295

Stabilizers

Alkyd tin mercaptide, liquid	lb.	2.50	3.15
Barium-cadmium complex, liquid	lb.	.50	.585
Solid	lb.	.97	1.25
Barium-cadmium laurate	lb.	.87	.90
Myristate	lb.	.72	.75
Barium-cadmium-zinc complex	lb.	.54	.56
Barium-zinc, liquid	lb.	.58	.615
Powder	lb.	.375	.44
Complex	lb.	.47	.50
Cadmium-barium, powder	lb.	.68	.895
Chelating agent, liquid	lb.	.57	.84
Cadmium-containing	lb.	.84	.87
Zinc-containing	lb.	.62	.80
Organic complex, liquid	lb.	.57	.845
Strontium-zinc laurate	lb.	.72	.75
Zinc, liquid	lb.	.48	.52

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